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1 Introduction

Barney Warf

Like the wheel and the printing press, the internet has had, and continues to have, profound impacts on the world. Roughly 55% of the planet used the internet in 2019, and for users it has deeply affected communications, consumption, entertainment, politics, and culture. In ways ranging from electronic banking to online education, internet gambling and videogames, e-government and e-commerce, YouTube, Twitter, Facebook, and Google, the internet has become woven into the world economy and everyday life. Never have so many people been able to contact one another so easily, obtain news, purchase goods, file complaints, and save time than today. For large numbers of users, the real and virtual worlds have become inextricably intertwined; for them, the internet is a necessity, not a luxury. Seen this way, the dichotomies off-line/on-line does not do justice to the diverse ways in which the “real” and virtual worlds are interpenetrated. However, for those without access to the information highway, the internet may represent a new source of inequality.

The internet may be defined as a global system of interconnected computer networks, that is, a network of networks, which billions of computers across the planet. Its decentralized architecture allows any computer to communicate with almost any other using the Transmission Control Protocol and Internet Protocol (TCP/IP), the language that allows routers and servers to exchange information with one another. The speeds of connection vary considerably, but have become ever-faster with the widespread adoption of fiber optic cables. In the 21st century, as cellular phones have become ubiquitous, wireless connectivity has become widespread. The World Wide Web is part of the internet, consisting of documents written in the hypertext markup language (HTML), which enables them to be accessed by web browsers. Users find documents on websites, each of which may have several webpages, using their unique Universal Resource Locator (URL) codes. The WWW contains countless billions of hypertext documents, including not only text but figures, music, and video. Finally, cyberspace, a term coined by science-fiction writer William Gibson (1984), refers to the digitized, virtual “world in the wires,” that is, computer-mediated communications, augmented reality, and virtual

reality. Although cyberspace is often conceived as a domain independent of the “real” or physical world, in reality the virtual and real worlds shape each other continuously.

A brief history of the internet

The internet has a relatively short but fascinating history. (For more thorough treatments, see Hafner and Lyon 1996; Banks 2008; Ryan 2013). It originated in the 1960s under the U.S. Defense Department’s Agency Research Projects Administration (ARPA), which designed it to allow computers to communicate with one another in the event of a nuclear attack. ARPA gave rise to innovations such as packet switching, neural networks, queuing theory, adaptive routing, and file transfer protocols. In the process, it created a network quite different from the centralized system of the telephone company (i.e., the monopoly once held by AT&T), which relied on analogue information: rather, the process of digitization facilitated a decentralized, then distributed network. The earliest signs of what eventually became ARPANET connected universities such as Stanford, UCLA, the University of California at Santa Barbara, and the University of Utah. Over time, the military goals were soon supplemented by civilian ones. In 1972, Ray Tomlinson created the first computer messages for personal use, inventing email.

Administration of the internet has varied over time. Between 1984 and 1995, it fell to the National Science Foundation, which transformed ARPANET into NSFNET, a largely academic network of supercomputers in a few select universities. Meanwhile, the world’s first cybercommunities arose, such as the WELL (Whole Earth ‘Lectronic Link) in San Francisco. On the border of Switzerland and France, the European Particle Physics Lab (CERN) developed hypertext and Universal Resource Locators (URLs), making possible the World Wide Web and user-friendly browsers. Tim Berners-Lee, often called the “father of the World Wide Web,” played a key role in this process. In the 1990s, amidst a wave of neoliberal privatization, the U.S. government shifted control to a consortium of telecommunications corporations. Meanwhile, the system began to explode in use on an international scale. The number of websites grew exponentially, from roughly one million in 1990 to almost eight billion in 2019. Next to the mobile or cellular phone, the internet is the most rapidly diffusing technology in world history. Global access deeply shaped by the density, reliability, and affordability of fiber optics lines, which were being laid down in large numbers.

In the late 1990s and the 21st century, two developments greatly affected the internet: Web 2.0 and the rise of the mobile internet. Web 2.0 allows users to contribute material to webpages rather than simply consume their information passively, allowing users to upload content and enjoy instantaneous interactions. Thus were born Amazon, Facebook, YouTube, Wikipedia, and location-based services. The invention of smartphones, or phones that can

access the internet, gave rise to the mobile or wireless internet (Arminen 2007; Kellerman 2010). Rapid decreases in the cost of mobile phones made them affordable for vast numbers of people; today more than 90% of the planet owns one. Mobile internet access is particularly important in the developing world. The mobile internet greatly enhanced its accessibility, adding flexibility and convenience. Text messages and Twitter have become common for vast numbers of people.

As the internet became more user-friendly and computer costs declined, the number of the world's netizens world skyrocketed (Figure 1.1). In December, 2019, more than 4.5 billion people used the internet, approximately 58% of the world's population. However, the geographical distribution of internet users is highly uneven: internet penetration rates are far higher in the developed world than the developing one, although they are rising rapidly everywhere. internet growth, however, has still excluded almost half the planet, a phenomenon known as the digital divide, or unequal social and spatial access. This phenomenon takes many forms, including class, education, gender, ethnicity, and age. Everywhere, the young are most likely to use digital technologies; many young people are digital natives, never knowing what the world was like before the internet. Readers of a certain age who recall pre-internet days are in a sense similar to the last generation to experience the world before the automobile became widespread in the early 20th century.

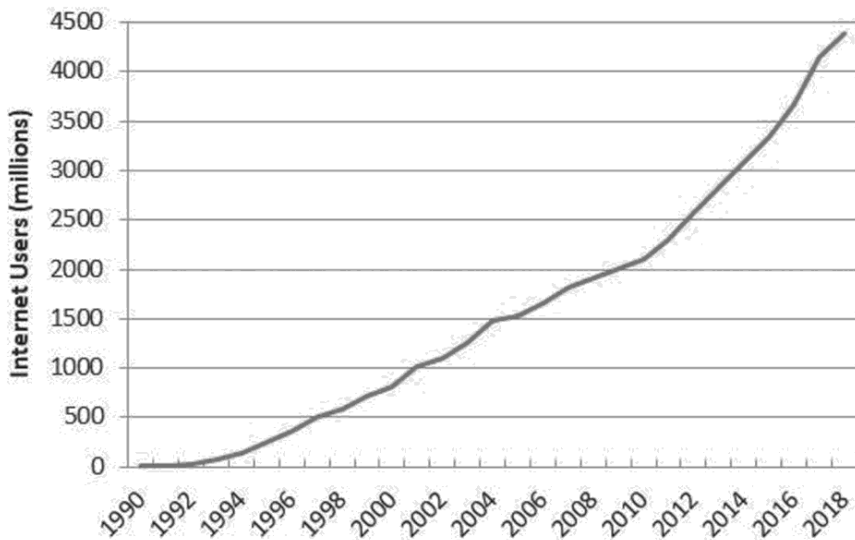


Figure 1.1 Growth in global internet users, 1990–2018.

Source: Author, using data from Internet World Stats (Internetworldstats.com).

The impacts of the internet

The internet has such a large number of effects on peoples, societies, and places that it is difficult to list them all. Some of the major consequences include the economy, social and behavioral effects, and political ones that include governance.

Economic impacts

The internet's economic effects extend into every part of the economy. Farmers can use the internet to manage supply chains, logistics, and output, and control irrigation systems remotely (McKinion et al. 2004). Telecenters in countries such as India allow farmers to acquire information about crop prices and best practices, acquire land titles, and bypass corrupt and intermediaries (Pick et al. 2014). In manufacturing, the internet has given new power to machinery, including robots and artificial intelligence (Caputo et al. 2016). Producer services, too, have been markedly altered, such as with the movement of many clerical functions, call centers, tax preparation, and radiology jobs to the developing world. In finance, enormous sums of funds move at the speed of light through the world's fiber optics networks. Internet banking has reduced the need for labor at the retail end, lowering costs, improving efficiency and convenience (Hanafizadeh et al. 2014). Digital currencies such as Bitcoin are profoundly affecting money supplies and currency markets, while crowdfunding has let many projects emerge that otherwise would have been starved for investment funds.

Consumption, too, has been reshaped by the internet. Advertising has been revolutionized by adware (Hanafizadeh and Behboudi 2012). e-Tailing allows shopping with a few clicks of the mouse, giving rise to giants such as Amazon. Increasingly, old-fashioned brick-and-mortar shopping is giving way to "click-and-order" (Forman 2009). Supply and distribution networks have evolved accordingly. The internet allows, for example, small producers to reach global markets, a boon to small firms in the developing world.

Electronic commerce, or e-commerce, has several varieties. Business-to-business (B2B) ecommerce includes electronic data interchange (EDI) transactions and greatly accelerated product cycles and enhanced competition. Business-to-consumer (B2) e-commerce links suppliers and customers via the web, dramatically altering the volumes and quantities of items bought (e.g., Amazon Prime) (Gong 2009). Business-to-government (B2G) e-commerce involves transactions between private firms and the state, such as requests for proposals; applications for permits, licenses, and patents; online registration of companies; obtaining government contracts; and paying various types of taxes.

In transportation, the internet has unleashed waves of change (Thomopoulos et al. 2015). Smartphones and laptops allow people to work

while travelling or at home, for better or worse. Global positioning systems (GPS) have made driving and finding locations far easier. With telework or telecommuting, many employees can work at home. Smart traffic systems have made roads faster and safer. Firms such as Uber and Lyft have created enormous competition for traditional models of transportation. Tourists can use the internet to obtain information about prospective destinations, book hotels, buy tickets, and reserve cars (Condratov 2013; Standing et al. 2014). Taxi drivers and travel agents represent victims of the internet's "creative destruction."

Energy production and consumption have also been greatly affected by the internet. For example, parallel and distributed computing has raised the efficiency of energy suppliers in the face of constraints such as security and environmental limitations. Smart grids – computerized controls and sensor networks – allow for more efficient ways of managing electricity supply and demand, improving the generation, transmission, distribution, and applications. Smart cities, which integrate information technology in numerous ways, including smart traffic systems and smart homes, are a viable means of promoting sustainable development, fostering renewable energy sources, and reducing carbon use (Strengers 2013; Komninou 2014).

Social, behavioral, and psychological impacts

There are innumerable social and behavioral impacts of the internet. Today, more people are more connected technologically to one another than at any other time in human existence. More than one-half of the world's population uses the internet, and social media platforms such as Facebook and Twitter have become thoroughly intertwined with daily existence as a means of communication, news sharing, organizing, and protest. Email is indispensable for almost all internet users: the world sends 145 billion email messages each day. Smartphones and texting have become ubiquitous: the planet sends more than 250,000 text messages every second. Blogs and YouTube have given unprecedented numbers of people the ability to make their views heard.

Digital communications and social media have played significant roles in the formation of individual and social identities, allow people to stay in touch with like-minded others to form classic "communities without propinquity." Some observers argue that meaningful interactions are invariably preceded by earlier face-to-face ties and that digitally mediated communities are ephemeral and lack emotional depth. Digital social media may actually make people less, not more, sociable (Turkle 2011). The internet may even generate subtle changes in brain structure, such as shortened attention spans (Carr 2010). The enormous enhancement of human extensibility that the internet allows has shifted many social interactions from a series of one-to-one ties to networks of one-to-many connections (Adams 2005). Digital networks allow people to present different sides of themselves to different audiences, allowing

for fragmented, multifaceted selves to co-exist in one body. Digital media also blur the borders between public and private life. For many people, the digital, on-line self and the non-digital, analogue self have become hopelessly entangled. The internet has thoroughly reshaped many forms of entertainment, including on-line television (e.g., Netflix), videogames, music, and publishing. Online dating sites and pornography have affected sexuality, as have sexting and cyberstalking.

These issues raise serious concerns about digital privacy. Corporations can use data mining to targeted online advertisements and collect propitious volumes of information about individuals, often reselling this data to other vendors. Search engines such as Google or the U.S. National Security Agency collect unimaginable quantities of information about people. The public digital data about private individuals reflects the panopticonic tendencies of contemporary capitalism to monitor and control citizens' behavior.

Education and health care have been reconfigured by cyberspace. The rise of online courses has been steady and inexorable. Libraries have changed their purpose to become repositories of digital data (Herring 2014). Health care has witnessed the rise of telemedicine, telesurgery, and e-health, in which patients can look up diseases, disorders, symptoms, drugs, and solutions (Ball and Lillis 2001).

Political and governmental impacts

The political world has been drastically transformed by the internet. Whereas journalism has been digitized, and traditional newspapers have had to adjust, social media also allows for the propagation of fake news. Blogs have become an important part of political campaigns and commentary. Internet law, or cyberlaw, is another field in which these effects are being felt, including issues like e-contracts, electronic signatures, digital intellectual property rights, and copyright and trademarks (Rustad 2014; Lipton 2015). Other issues concerns pornography, hate speech, online defamation, cybercrimes, internet privacy, and the Right to be Forgotten. Yet other topic concerns the regulation of the internet itself, including issues such as net neutrality. Cybercrimes take a variety of forms, including hacking, identity theft, credit card fraud, and the use of malware such as ransomware, spyware, and phishing.

Electronic government, or e-government, is another example of how the internet is altering the social fabric of societies (Fountain 2001; Davison et al. 2005). E-government includes online contract proposals and submissions of bids, bills, and payments, digital payments of taxes, electronic voting, payment of utility bills, fines, and dues, applications for permits, and licenses, online registration of companies and automobiles, and access to census and other public data. E-government is often held to improve the efficiency of the public sector, raise transparency, and reduce corruption. However, e-government often fails in developing countries (Dada 2006). Finally,

internet censorship reflects how some states fear the internet, which allows groups to bypass government monopolies over information access (Deibert 2009). Governments face a choice in the degree of censorship, leading to wide geographic variations (Warf 2010) in its *scope* (or range of topics) and *depth* (or degree of intervention).

Political impacts of the internet also include cyberterrorism and cyberwarfare. Cyberterrorism involves the use of the internet to damage computers and information systems, including the infrastructure, as a result of political motivations (Chen et al. 2014). Cyberterrorism is not simply an attack on human beings, but a way to physically cause damage to the infrastructure. Cyberwarfare attacks can disrupt a country's infrastructure and communications systems, including financial markets, through the use of malicious code. In dissolving the boundaries between the civilian and military spheres, state and non-state actors, the foreign and the domestic, war and peace, cyberwar shifts the location of the battlefield. Given its rising importance, in 2009 the U.S. military established the Cyber Command expressly to wage cyberwar and defend against cyberattacks (Harris 2014).

Misconceptions about the internet

There are numerous myths that swirl around the internet that stem from simplistic readings of the relations among society, information technology, and space. One of the most common is technological determinism, a view that portrays technologies as the driving force behind social changes and views society as the passive recipient of them. This line of thought, which is surprisingly common, often portrays cyberspace as the aura of some omnipotent, external actor that drives all other changes, ignoring or marginalizing the social, political, and cultural contexts in which the internet is invariably situated. Technological determinism denies the historical and geographical contingency that characterizes the origins and growth of the internet, and how societies shape cyberspace as much as they are shaped by it. Rather than this simple determinist view, it is more productive to view the internet and its social contexts as simultaneously determinant, shaping one another in multiple, contingent, and unpredictable ways.

Another misconception holds that the internet is only a force for positive changes, as noted in discourses that proclaim it to be inherently emancipatory. Undoubtedly the internet has made obtaining vast amounts of information easier and more convenient, helped to make governments more transparent and efficient, raised productivity, made travel safer, faster, and more convenient, allowed easier shopping, banking, and payment of bills, and revolutionized entertainment and education. Yet inevitably there is the ominous "dark side" of cyberspace, including spam, cybercrime, identity theft, viruses, cyberattacks, bank and credit card fraud, and more. The internet can be used against people as well as for them. Many totalitarian

governments have deployed it to great effect to monitor and control citizens and spread propaganda. Ignoring this dark side leads to unrealistic and overly optimistic interpretations of cyberspace.

A significant concern about cyberspace is the “digital divide,” the social and spatial inequalities in access that threaten to reproduce social inequalities. Almost half of the world consists of information have-nots, typically those in poor countries, the socially and politically marginalized, the poor and uneducated, and, disproportionately, women. Even in highly developed countries there are pockets of “off-line” citizens. Early expectations that the internet would eliminate inequality and poverty proved to be unfounded. Rather, the digital divide has persisted over time, assuming different forms in different contexts. Thus, as broadband has become the most important medium to send large files over the internet, broadband access is central to the digital divide. This division mirrors the increasing polarization of Western societies in general in an age of unchecked neoliberalism. In an historical moment in which social life is increasingly mediated through computer networks, discrepancies in internet access threaten to sustain and reproduce class, ethnic, and gender inequalities.

A third myth pertaining to the internet is that it annihilates space, rendering geography meaningless. Numerous authors proclaimed the ostensible “death of distance,” the “end of geography,” and a “flat world” (Friedman 2005). Combatting these simplistic assertions, which typically arise from technological determinism, geographers have illustrated and charted the spatial dimensions of cyberspace, its uneven social and spatial diffusion, and how its impacts assume different forms in different contexts (Kellerman 2002, 2016; Zook 2005; Warf 2012). This literature demonstrates the rootedness of cyberspace in social relations and serves as a necessary antidote to many prevailing utopian and technocratic interpretations.

Outline of this volume

This volume consists of three intertwined sections that address different facets of the spatiality of the internet. Part I concerns the history, technology, and geographies of the internet, that is, how its various components came into being, the various modalities that give it concrete form, such as fiber optics, and its uneven spatial distribution. Part II focuses on the political economy of the internet, that is, its impacts on commerce, retail trade, and tourism, as well as e-government; it also addresses the sticky issue of the Chinese web, where politics and economics are seamlessly fused. The third part addresses the internet in everyday life, where applications such as Google Earth, Twitter, and augmented reality have increasingly blurred the boundaries between the virtual and physical worlds, as well as its implications for neogeography, ethnography, and diaspora studies. It concludes with the Internet of Things, in which billions of devices have become web-enabled.

Initiating Part I with Chapter 2, Aharon Kellerman explores the definitions and changing meanings of cyberspace. He delves into the relations between cyberspace – the world in the wires – and virtual and internet spaces. He then turns to the inter-relations between cyberspace and the physical, analogue world, and concludes by examining cyberspace as a hybrid space.

“The World Wide Web as Media Ecology,” the title of Chapter 3 by Michael Black, offers a media studies perspective on the history and geography of the World Wide Web. He discusses several technologies that shape the topology of the web, particularly hyperlinks. With roots stretching back to the 1940s, hyperlinks evolved over time to create a fundamentally new form of knowledge creation and storage, one widely used today. In the 1990s, Tim Berner-Lee’s new web-based platform rapidly grew into today’s internet using an alphabet soup of acronyms such as HTML, HTTP, and URLs. The essay takes the reader through the rise of numerous means of surfing the web and the browser wars of the 2000s. Today’s Web 2.0 therefore, is the contingent, path-dependent outcome of a long series of experiments involving programmers, corporations, and users.

Ramakrishnan Durairajan, in Chapter 4, discusses the robustness and/or fragility of the internet in light of its geographically grounded infrastructure. In presenting the topological structure of the internet, particularly its fiber optics routes, he touches on a series of inter-related topics: dark fiber; data centers; mishaps that disturb network functionality; and the poorly understood complexity of the entire system. He illustrates this topic with a series of long-haul fiber maps.

Chapter 5, by Elizabeth Mack, concerns the history of broadband. From its origins in the Cold War to its diffusion among the public in the 2000s, broadband vastly accelerated the speed of internet connections. She discusses the variety of platforms used, including wireless broadband, and the numerous innovations that sprang forth from this technology, such as web browsers, Web 2.0 and smartphones. Broadband has been extensively studied in terms of its economic impacts and social benefits. Mack concludes with comments on the broadband digital divide and the future of the technology.

The mobile internet is among the most important features of cyberspace today. For many people, it is the only means of logging onto the information highway. Matthew Kelly, in Chapter 6, looks at the history of the mobile internet in light of the smartphone, and the associated growth of Webs 1.0, 2.0, and 3.0. The chapter addresses the impacts on everyday life, such as locative technologies, contextualized data and algorithmic searches, and mobile artificial intelligence. The chapter also addresses the seen and unseen consequences of mobile internet use, including the mobile digital divide and privacy concerns.

Rural areas throughout the world have been frequently left behind by the internet revolution. Jeffrey James takes up this topic in Chapter 7, in which he discusses the reasons behind the lower internet penetration rates there. The urban–rural divide is one of the foremost characteristics of the geography

of the internet. James notes the potential benefits the internet offers to rural denizens, including telemedicine and educational opportunities, and the possibilities opened up by mobile internet access there. Constraints include the costs of access and thus affordability and the lack of user capabilities (e.g., literacy). He concludes by examining policy options.

Digital divides at multiple spatial scales are a significant feature of inequality in cyberspace. At the global level, James Pick and Avijit Sarkar, in Chapter 8, summarize the global digital divide, which, as they note, is really more of a continuum than a dichotomy. Their analysis reveals how the divide has changed over time, various measures of the phenomenon, and how it can be fruitfully theorized. They then turn to factors that influence digital divides, such as demography, geographic location, employment status, policy measures, and social capital. They emphasize the spatial unevenness of divides, and discuss its status in the United States, China, India, Japan, and Africa.

Part II, on the political economy of the internet, opens with Chapter 9, by Bruno Moriset, who focuses on e-commerce, which has exploded in size and significance. All over the world the internet is reshaping supply chains, product cycles, and corporate strategies, and has given rise to behemoths such as Amazon. Moriset explores various forms and business models of e-commerce, its links to the gig economy (e.g., Uber) and the rise of the “winner-take-all” economy, in which large firms gain via their economy of scale. But e-commerce has diffused unevenly across the planet’s surface; in the U.S. its role is limited compared to that in China. The chapter also focuses on the role of tax regimes in shaping this geography as well as the logistics involved. Moriset then turns to how e-commerce has affected local economic landscapes, including retail trade. He concludes by looking at the impacts on rural areas.

One particularly important part of e-commerce is electronic retailing, or e-tailing, the subject of Chapter 10, by Emily Fekete. Electronic sales constitute a growing part of retail sale revenues, and the phenomenon has changed how people conduct shopping. The chapter traces the origins and growth of online shopping. Fekete shows that far from simply displacing “brick and mortar” shopping, e-tailing often complements it. She concludes by examining alternative online places of shopping.

In Chapter 11, Jayson Funke delves into the world of fintech, where finance and technology intersect. He notes that “Financial systems are inherently information systems,” and explores how territory, finance, information, and technology have become seamlessly integrated. He embeds this topic within wider understandings of neoliberalism and the financialization of the economy, including global debt, which gave rise to global financial flows that cross borders with ease. Along the way, fintech gave rise to spin-offs such as NASDAQ, offshore financial centers, big data analytics, and cryptocurrencies such as Bitcoin. The chapter concludes with a warning that practices such as credit scoring are integral to the panopticonic operation of contemporary capitalism.

Tourism, the world's largest industry in terms of employment, has also felt the repercussions of the internet revolution. One out of six people in the world is a tourist annually. In Chapter 12, Irene Cheng Chu Chan and Rob Law analyze the origin and growth of e-tourism. They look at the technologies that have reshaped the industry, giving rise to a new business model, online travel agencies, as well as the adoption of artificial intelligence. They also address key issues and debates, such as the impacts on consumer behavior and demand, business functions such as intermediaries, and marketing. They conclude by turning to the spatial implications of this transformation.

Barney Warf explores the spatiality of e-government in Chapter 13. All over the world, the internet has reshaped how states interact with their citizens. Warf opens by noting the varieties of forms of e-government. He then proceeds to theoretical perspectives on the topic, including various stages models and the widely used technology acceptance model. The next part concerns obstacles to the successful implementation of e-government, such as gender roles, resentful bureaucrats, and the digital divide. The chapter concludes with an examination of e-government in practice in three East Asian cities, Shanghai, Seoul, and Singapore.

China has the world's largest population of netizens (roughly 850 million in 2020). In Chapter 14, Xiang Zhang summarizes the multiple dimensions of the Chinese internet. He examines the rapid growth of cyberspace there and the persistence of a digital divide in the country. He describes the geography of China's internet in light of its profoundly uneven spatial development. The chapter then describes the growth and geography of e-commerce in China. The chapter concludes by noting the controversies pertaining to the internet in China and challenges to the government's strict censorship, such as the Great Firewall.

Todd Patterson's examination of Google Earth comprises Chapter 15, which initiates Part III. The most widely used virtual globe, Google Earth and its by-products (e.g., Google Street View) have had profound impacts of geographical imaginations across the planet, enhancing, as he notes, spatial thinking and education. It has also found its way into a variety of personal applications, such as virtual tours of parks, and in government, such as national security and public service provision. Academics have used Google Earth to study the structure of urban land use and in health geographies. Commercial applications include land cover studies and engineering services. Patterson also notes how it has been incorporated into consumer technologies such as location-based services.

The internet has opened up new worlds of human experience in which the physical and the virtual become hopelessly entangled. Mark Billinghurst, in Chapter 16, writes about augmented reality (AR), in which digital technologies complement the senses in real time (unlike virtual reality, which replaces the real world with a digitized immersive environment). The chapter illustrates the characteristics of augmented technologies in detail and their evolution over time, using copious illustrations. From head-mounted displays

to smartphones, today vast numbers of people have access to this technology. The chapter also notes the applications of AR in multiple contexts, including architecture, health care, marketing, and entertainment.

As social media has exploded in its number of users and applications, Twitter has emerged as one of the dominant forms of communications over the internet. More than 335 million people worldwide tweet today. Matthew Haffner, in Chapter 17, begins with the history of location tagging or geotagging and then the rise of crowdsourced geographic information, which raises a number of issues and questions. He also studies how Twitter is used, such as continually streamed, spatially differentiated content production. Twitter has been used to analyze geographic trends in word usage, trip generation patterns, and hazards and disaster research. The chapter concludes by examining challenges in the use of Twitter data, such as gender and racial biases, computational dilemmas, and privacy concerns.

In Chapter 18, Wen Lin takes up the topic of neogeography, the production of spatial knowledge by non-experts. User-generated geographic knowledge has grown rapidly, and its implications are unclear. Lin discloses the origins of neogeography, then moves to on-going debates in the field, discussions about how spatial data is collected, and the social and political ramifications. For example, there exists a widespread impression that neogeography is inherently empowering and facilitates participant mapping. Finally, she addresses the subjective experiences of neogeography and its potential to introduce affect and emotion into cartography.

The internet has become indispensable to research of multiple kinds. In Chapter 19, Tyler Sonnichsen focuses on its use in ethnography. As ever-larger domains of human interaction move online, the web offers a wealth of ethnographic data, notably on social media. The study of internet-mediated communication has become a discipline unto itself. Much more than simply text, the material for such research includes images and videos, as YouTube, Snapchat, Tumblr, Skype, and Instagram attest. Smartphones offer yet another avenue to pursue this line of work. Online ethnographic works also allows insights into the role played by affect and emotion, the pre-linguistic landscape that underlies much of human behavior that is typically understood through non-representational theory. Sonnichsen concludes by turning to the ethics of such work, which often turns many people into inadvertent subjects.

Digital diasporas are another burgeoning field of internet-related research. In Chapter 20, Michel Laguerre elaborates on how different generations of immigrants use social media to forge linkages between their home and host countries. These cross-border online linkages form a cosmonational space. Laguerre examines the research dimensions of this phenomenon, the politics of foreign policy that are frequently involved, and how race and gender enter into this issue in complex ways. Social media, in this reading, leads to online performances of identity. He concludes with comments on the cyber-cartography of digital diasporic communities.

Chapter 21, by Monica Murero, concerns a new development in the geography of cyberspace, the wearable internet. The miniaturization of digital technologies has led to a proliferation of internet-connected watches, rings, headsets, glasses and health care devices. The data produced by these items – part of the broader Internet of Things – serve multiple purposes: users can track their own health; marketing companies utilize them; they serve as navigational tools; and they are useful for location-based services. Murero traces the surprisingly long history of this technology and the new territories they open up, such as implanted devices. She describes how they work, such as the sensors, monitors, Bluetooth connections, and the rapid proliferation of apps that service them. She examines controversies surrounding the wearable internet, including surveillance, the quantified self, and artificial intelligence. The chapter concludes by stressing the need for regulation of this industry.

Anurag Agarwal and Bhuvan Unhelkar, in the last chapter (22), conclude the volume by describing the Internet of Things (IoT). Today more devices are internet-enabled than there are people in the world. They start by outlining the history of the IoT, and move on to its industrial counterpart, the Industrial Internet of Things. They summarize the innumerable applications of this innovation, notably in the realm of geospatial technologies, the challenges involved in its use, and note future research directions. In an age of ubiquitous, mobile, and invisible computing, the IoT may well define the future of the internet.

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2 Is cyberspace there after all?

Aharon Kellerman

Gibson (1984) originally proposed the term “cyberspace” in his novel *Neuromancer*, as a science-fiction notion. The term acquired its connotation for a rather metaphorical space within which the internet operates, as of the early 1990s, towards the commercial introduction of the internet in 1995. The use of the term cyberspace for a class of virtual space was simultaneously coupled with the adoption of numerous additional terms, borrowed from words and terms originally coined for the use of physical space. These terms included, for instance, the words home, site, link, browsing, moving, and more. The adoption of a geographical language for the emerging uses of virtual entities, at the time, reflected the primal role of physical space and its uses in human life, thus making it easy for individuals to operate within virtual entities, notably the internet (Schlottmann and Miggelbrink 2009; Kellerman 2016).

This chapter will present and discuss four dimensions concerning the notion of cyberspace, and its adoption for virtual space in general, and for the internet in particular. First, it will present the meanings, uses, and interpretations of cyberspace, proposed notably from the mid-1990s until the early 2000s. Second, it will describe the relationships between cyberspace and related image spaces, notably virtual space and internet space. Third, it will outline some of the relationships between cyberspace and physical space, and fourth, it will discuss two notions, which have been proposed following the wide dissemination of the metaphorical cyberspace. The first among these two notions will be hybrid space, emerging in the 2000s, and it will be followed by the notion of spatial media, developing in the 2010s. Thus, the following discussions will attempt to cope with the question posed soon after the beginning of the geographical exploration of cyberspace: “Is cyberspace a kind of space?” (Adams and Warf 1997, 141).

Meanings of cyberspace

Numerous meanings and features of cyberspace as a geographical concept and entity have been proposed, notably through the 1990s. From a spatial perspective, cyberspace was widely viewed as synonymous with information

hypertext documents. In 1994, Berners-Lee founded the World Wide Web Consortium (W3C), a non-profit organization that would manage the HTML language in order to ensure that it would remain an open standard. Although the W3C maintained an official definition of each of HTML's mark-up "tags," both Microsoft and Netscape introduced new tags in an effort to style their browsers as more fully featured than the other – `<marquee>` and `<blink>`, respectively. Neither of these tags were a part of the W3C's definitions and were not, until more recently, supported by competing browsers. While the Browser Wars effectively ended with Netscape's transformation into the non-profit Mozilla Foundation, beginning in 1998 with the open sourcing of its browser software, the consequences of the conflict between the two developers extended into the next decade (Cusumano and Yoffie 1998). As HTML has expanded to incorporate other document languages, like Cascading Style Sheets (CSS), Microsoft's and Mozilla's web browsers interpreted many of the new hypertext elements differently. Throughout the late 1990s and early 2000s, it was not uncommon to see a "Best Viewed With" label in the footer or navigation frame of a webpage, indicating which browser the author had written their code towards. Designing a document to look similarly across all browsers, depending on the complexity of its code, required extensive testing and may have even required developers to write separate CSS definitions for each browser.

By the late 2000s, the hand-coded nature of the early web gave way to the automated page generation of content management systems. Whereas during the web's first decade, authoring and reading hypertext documents on the web required two different pieces of software – a text editor and a web browser, respectively – content management systems enabled web authors to add an interactive online interface to their websites, allowing them to add to or change their website through their browser. Instead of having to use a text editor to author new documents in their entirety, content management systems provided a template shell and database backend that would store the media content of all pages and ensure that they were displayed with a uniform look and feel across a website. When using a content management system, authors visit a designated interface page on their website, enter their login credentials, and begin writing text, styling their documents, and uploading other media content through a series of forms. Once the document is ready to be made available on their site, authors select to "publish" it to a URL. Whenever a reader visits that URL, the content management system processes the document's contents through the website's template and produces a page populated with the new content that matches the overall look and feel of the rest of the site's pages. Today, there are a variety of content management systems available, including a variety of open source packages such as Drupal, Joomla, Jekyll, and Wordpress.

Content management systems helped to alleviate many of the difficulties associated with hand-coding hypertext web documents, including accounting for differences in browsers. At the same time, however, they have also

contributed to a homogenization of design across the web. Although Berners-Lee envisioned a web on which everyone connected server machines that they themselves owned, this structure of the web existed only very briefly. Instead, many web authors established websites through “hosting services.” Prior to the rise of content management systems, many hosting services – both free and paid alike – provided their users with nothing more than a URL for their website and a directory to which they could upload their hand-written HTML documents using file transfer protocol software. Popular early hosts like Angelfire, Geocities, and Tripod imposed few, if any, restrictions on website design initially, apart from inserting advertisement frames in lieu of charging authors a hosting fee. Many modern hosts, however, utilize content management systems; and while content management systems allow authors to customize the template shell of their websites, some hosts may restrict customization or impose a fee to adjust certain features of the template. Even in cases when users have relative freedom to make adjustments to a content management system’s template, invariably all websites created with a specific content management system will share some base level of design features that are a product of the algorithms that compile a website’s documents from the site’s content database.

Just as content management systems have automated many aspects of web authoring, today’s search engines are made possible through automated web reading. Google’s current dominance of web search is predicated upon its web crawling software, an algorithmic system for following links across websites and storing information about them to populate its search database. Google did not invent web crawler software or automated search engines. Before Google was made publicly available in 1997, services like AltaVista (1995), Excite (1995), Lycos (1994), and WebCrawler (1994) also implemented crawlers. Some of these services attempted to implement a portal interface, mimicking the popular directory style of Yahoo!. Google’s initial rise in popularity has been attributed, at least in part, to its comparatively minimalist interface. When it first launched, Google presented its search service as a simple tool: a textbox beneath a static, unchanging logo that was not linked to a larger service suite. It loaded quickly and made simple, fast queries possible on a variety of bandwidths.

Structurally, search engines like Google have become a focal point for our web reading practices. In place of the networked experience of traversing hyperlinks from site to site in search of information, search engines have effectively flattened the web. Only web crawlers continue to experience web reading as a practice of networked discovery. Instead, most users expect search engines to bring content to them. In this respect, Google’s popularity in the long term has been sustained by its PageRank algorithm, which attempts to match search queries against the full text of documents in its web crawler database, ranking them through a series of relevancy scores that weight, among other things, the number of times other users have clicked a link among search results for similar queries. Thus, as Safiya Noble argues, search engines

like Google function not merely as tools but as knowledge institutions that manage our relationship to information. Because search engines now serve as primary entry points for a significant portion of our web interactions, they are flattening our perception of the web and centralizing our experience of it around the databases constructed by their web crawlers. Officially, search engine services like Google present their technologies in objective terms, pointing to a series of mathematical and natural language processing theories to justify the structure of their ranking and relevance algorithms. But as Noble's work shows, these algorithms inevitably reproduce the social and cultural biases of their designers – just as any other institution would reproduce the biases of the people working within it, intentionally or otherwise (Noble 2018). Google is not the only service that flattens the web. Social media services like Facebook, Reddit, and Twitter also similarly draw in links to information sources from around the web. Each of these services tries to effect its own kind of web cultural cachet but few, apart from Facebook, have aspired to attain the same level of authority over the web itself as Google.

Together, the automated content management and search systems that now support so much of our experience as authors and readers of the web have fundamentally changed our experience of it. Because URLs now serve as commands for document generation rather as links to static documents, the topology of the web has taken on an M.C. Escher-like quality. When working in concert, the automated writing and reading systems of the modern web erase the boundaries between documents, sites, and services, leading us back to the same locations even as we try to follow links in new directions. Google is not just a website we use to search, as Siva Vaidhyathan explains, it is a center of power that exerts a kind of “infrastructural imperialism” by weaving itself into other automated web systems (Vaidhyathan 2012). Consider, for example, Google's AdSense marketing service which links a history of search queries to a person's account – or, failing that, to their browser through identification codes stored as “cookies.” AdSense can be woven into a content management system to populate web sites with advertisements micro-targeted towards a reader's presumed interests. When moving from page to page within a web site, or even across sites, AdSense continually presents its content to readers, meaning that the same or similar content will now follow readers across the web. Advertising and recommendation systems shape the web's landscape for us, continually directing us towards content they determine will be of interest to us.

Our sense of the web as a network can also be disrupted through the increasing prevalence of embedded objects. The content management systems developed for use by large media services, like YouTube, now allow for authors to embed objects from those services into their own websites. During earlier web eras, the practice of presenting content from another website as part of one's own was referred to variously as “hotlinking,” “direct linking,” or “inline linking.” The practice was considered a form of theft. Regardless of whether someone managed a website on their own server or used a hosting service, the

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