From Systems to "Infrastructuring": Infrastructure Theory and Its Impact on Writing the History of Media

Axel Volmar

Since the early 1990s, "infrastructure" as both an object and analytical concept has been a growing research interest in the social and human sciences. In the last ten years or so, the study of infrastructure has also experienced a lively boom in my own discipline, media studies. One reason for this heightened interest is the increasing interconnectedness of digital and data-driven media, which since the popularization of the Internet in the 1990s came to determine the everyday lives of many people. Moreover, the ubiquity of digitally networked media has increasingly directed the theoretical interest of media studies away from the computer as a "universal solvent"[1] to "the stuff beneath, beyond, and behind the boxes our media come in."[2] In recent years, the notion of "media infrastructure" has been taken up, for instance, in research on data-driven media (such as social media, digital platforms, and mobile applications), digital signal traffic, and media history.[3]

Recently, however, objections have been raised against the increased use of the infrastructure concept, warning that the term is being watered down or accusing its boom to be merely a fad. Charlotte P. Lee and Kjeld Schmidt, for instance, have complained that "the concept of 'infrastructure' has become increasingly muddled over time. Disparities in use of the concept have become an immense source of confusion […]. The unquestioned and seemingly unnoticed use of the term 'infrastructure' in

1 Paul E. Ceruzzi, *A History of Modern Computing* (Cambridge: MIT press, 2003), 346.

2 Johnathan Sterne, *MP3: The Meaning of a Format* (Durham: Duke University Press, 2012), 11.

3 See, for instance, Jean-Christophe Plantin and Aswin Punathambekar, eds., "Digital Media Infrastructures: Pipes, Platforms, and Politics," *Media, Culture & Society* 41, no. 2 (2019): 163–74, https://doi.org/10.1177/0163443718818376; Lisa Parks and Nicole Starosielski, eds., *Signal Traffic: Critical Studies of Media Infrastructures* (Urbana: University of Illinois Press, 2015), https://www.press.uillinois.edu/books/catalog/26bxm4qd9780252039362.html; Axel Volmar and Kyle Stine, eds., *Media Infrastructures and the Politics of Digital Time: Essays on Hardwired Temporalities*, Recursions (Amsterdam: Amsterdam University Press, 2021), https://www.degruyter.com/document/doi/10.1515/9789048550753/html.

myriad ways is hobbling the development of the area."[4] Similarly, David Hesmondhalgh criticizes "a tendency in media and internet studies to use the term 'infrastructure' in such a variety of ways that the term risks losing its analytical value; an uncertain engagement with ideas of materiality and 'relationality'; and a tendency towards banality and vagueness."[5] Despite the legitimate objections, however, the critics generally fail to solve the confusion they bemoan. For example, neither Lee and Schmidt nor Hesmondhalgh fully acknowledge the different scholarly motivations for extending the concept of infrastructure and for using it in the context of research in the humanities and especially in media studies.

The critical assessments, however, raise the legitimate question of what can actually be gained in theoretical-methodological terms by resorting to the concept of "infrastructure" as opposed to similar notions, such as "system," "network," "platform," or simply "technology." Or in Hesmondhalgh's words, it seems "worth asking why the concept of infrastructure is so seemingly fashionable *now*."[6] This essay attempts to trace the history of the concept of infrastructure and its fortune as an analytical concept in the social sciences and humanities. It aims to show what the fundamental fascination or promise of the concept of infrastructure is, what it means or implies, and why it can be useful to engage with materiality, relationality, and, yes, even banalities. I am particularly interested in outlining how an engagement with the concept of infrastructure can inform theoretical perspectives and research methods in the humanities. I will argue that infrastructural or even infrastructuralist ways of thinking emerged from a critical reinterpretation of the concept of infrastructure within the sociology of technology in the late 1990s and early 2000s, which since provided important impulses for the humanities.

What seems characteristic of this interest in infrastructures is not primarily the fact that humanities scholars turn to infrastructures as new research objects but that they developed the term "infrastructure" into an analytical lens, resulting in major reinterpretations of its meaning and methodological reorientations. My main argument is that a key feature of this shift is a move from a systemic understanding of infrastructure to a praxeological one, and this fact is also the reason why the different meanings of the infrastructure concept in current research discourses often seem so incommensurable. To clear up some of this confusion, I aim to show why

4 Charlotte P. Lee and Kjeld Schmidt, "A Bridge Too Far?: Critical Remarks on the Concept of 'Infrastructure' in Computer-Supported Cooperative Work and Information Systems," *Socio-Informatics: A Practice-Based Perspective on the Design and Use of IT Artifacts*, eds. Volker Wulf et al. (Oxford: Oxford University Press, 2018), 177–217, 178.

5 David Hesmondhalgh, "The Infrastructural Turn in Media and Internet Research," in *The Routledge Companion to Media Industries*, ed. Paul McDonald (London: Routledge, 2021), 132–142, 132, https://doi.org/10.4324/9780429275340-13.

6 Hesmondhalgh, "The Infrastructural Turn in Media and Internet Research," 140.

infrastructural thinking involves a strong focus on practices and how this has influenced methodological approaches. In the first section, I will look into how scholars from the social and human sciences first became interested in the notion of 'infrastructure' in the 1970s and 80s. I will then trace how, starting in the 1990s, the term underwent major reconceptualizations within the sociology of technology. In the last section, I will discuss some more recent examples that show how this conceptual shift has shaped—and can continue to inspire—new research topics and methodological approaches. While these examples stem from my own discipline, my hope is, however, that the general implications and the potential of infrastructural or infrastructuralist thinking that are shown in them might equally provide inspiration for scholars from other disciplines in the humanities.

1. From Systems to Infrastructures

In a way, of course, research in media studies and media history, especially those focusing on mass media, have in principle always been *infrastructure* studies. Hesmondhalgh, for example, accuses the rise of infrastructure theory in media studies of "seeming to have led to a neglect of other traditions of research, such as political economy of media, that might provide insights into the workings of media infrastructures as traditionally understood."[7] However justified this objection may be, it is important to note that the term "infrastructure" as such was rarely used in the early discourses of media studies research. Instead, the notion of "system" was much more common. In Harold Innis's foundational text *Empire and Communications*, for example, the term "infrastructure" does not appear once, while "system" is mentioned nearly a hundred times.[8] For Marshall McLuhan, too, for example in *Understanding Media*, media systems formed one class of systems among many others.[9] Similarly, in his standard work on the history of television, *Television: Technology and Cultural Form*, Raymond Williams refers to individual media as distinct systems that may follow each other in time or coexist.[10] In a similar but different vein, scholars of

7 Hesmondhalgh, "The Infrastructural Turn in Media and Internet Research," 132.

8 Innis mentions, among others, numerical, economic, administrative, agricultural, political, sign, and epistemic systems and even refers to customs and rituals as systems. Harold A. Innis, *Empire and Communications*, ed. David Godfrey (Oxford: Clarendon Press, 1950).

9 McLuhan talks, among others, about the railway system, the electric grid system, information systems and communication systems, though the term "infrastructure" does not appear in the book. Marshall McLuhan, *Understanding Media: The Extensions of Man* (New York: McGraw-Hill, 1964).

10 Williams mentions the general system of electric telegraphy, the telephone system, the system of television, the broadcasting system, and the North American communications system. Raymond Williams, *Television: Technology and Cultural Form* (London: Fontana 1974).

science and technology have addressed, since the late 1970s, the histories of transportation, energy, and communication infrastructures as "large technical systems" (LTS).[11] Moreover, in the 1980s and 1990s, German-language media cultural studies in particular liked to speak of "media compounds" (*Medienverbünde*), in which the entanglement of individual media were understood to provide the content for new compound systems.[12]

The concept of infrastructure as such remained primarily an actors' category for the first century after its emergence. The term first appeared in the French discourse of railroad engineering, where it literally referred to the built substructure of the rails, such as bridges, land cuts, or tunnels. From the 1920s onward, the term came to refer to military installations needed for combat operations and the general logistics of conflict. It was not until the second half of the twentieth century, however, that the concept of infrastructure came into general use, as it increasingly became part of public policy and political economy discourses, beginning with NATO position papers. There, the term was used to describe technical facilities as well as government institutions and services of national scope thought to support national economies and democracy.[13] This brief look at the history of the infrastructure concept already suggests that it does not merge with that of system. While a system can be an infrastructure or function as such, an infrastructure does not necessarily have to take the shape of a system. Infrastructure is first of all, a foundation, which, in the original sense of the term in railroading, compensates for the unevenness of nature (here, the territory) or, in a figurative sense, for the contingencies of everyday life. Infrastructures, both as resources in material form or in the form of labor and services, therefore, can be thought of more generally as exerting a levelling effect, allowing them to appear as something that can repeatedly be relied on and built upon to pursue even more far-reaching goals.

As a substructure or supporting structure, the term thus tends to draw attention to mediated relations between actors and environments and to evoke the presence of goal-oriented practices, for infrastructures are always infrastructures *of* something and *for* someone. Applied to the military's ability to act or to the development of national economies, the concept refers to facilities and precautions that have a supporting or catalytic effect intended to making processes run as smoothly as possible. Infrastructures in this classical sense can therefore be technical in nature (e.g.,

11 See Wiebe Bijker, Trevor Pinch, and Thomas Hughes, eds., *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge: MIT Press, 1987); Renate Mayntz and Thomas P. Hughes, eds., *The Development of Large Technical Systems* (Boulder: Westview, 1988); Jane Summerton, ed., *Changing Large Technical Systems* (Boulder: Westview Press, 1994).

12 See, for instance, Friedrich A. Kittler, *Grammophon, Film, Typewriter* (Berlin: Brinkmann & Bose, 1986), 8.

13 See also the introduction to this volume.

in the form of energy or water supply systems, or information and data infrastructures), in the form of public institutions (e.g., education or health care), or in the form of services and legal or regulatory frameworks. For example, the Internet is not only a distribution network for digital data, but also provides a base for the development of individual subsystems, such as websites, mobile applications etc. Because of this openness of purpose, infrastructure research has emphasized the *generative potential* of infrastructures.[14]

By pointing to what lies beneath, the notion of infrastructure further implies a vertical logic, which suggests the potential development of higher-order infrastructures. In this regard, Ingo Braun and Bernward Joerges studied how large technical systems can be interconnected to form "second-order systems," such as the systems of organ transplantation and hazardous waste disposal.[15] Applied to the history and present of digitally networked media, digital platforms, and mobile apps—and, ultimately, any development activity in the web that provides new functions and services—can be conceived as higher-order systems. This layered understanding of systems as infrastructures is important because it points to the fact that without the existing substructure, these systems would not exist (be it because they would not be feasible at all or because they would not be economically sustainable). Infrastructures are therefore usually linked to other infrastructures. Just as the track bed is the literal substructure for railroad tracks, the tracks are the substructure for railroads, and railroads are a general transportation infrastructure. Infrastructures, unlike closed systems or rhizomatic networks, are always already infrastructures of something and for someone.

2. Infrastructure as an Analytic Lens

The emergence of a suprisingly different theoretical interpretation of the concept of infrastructure has its origins in the early 1990s, when the term "information infrastructure" was coined in the field of public infrastructure policy.[16] As a catch-

14 See, for instance, Cymene Howe et al., "Paradoxical Infrastructures: Ruins, Retrofit, and Risk," *Science, Technology, & Human Values* 41, no. 3 (May 1, 2016): 547–65, https://doi.org/10.1177/0162243915620017; Kalle Lyytinen, Carsten Sørensen, and David Tilson, "Generativity in Digital Infrastructures: A Research Note," in *The Routledge Companion to Management Information Systems*, ed. Robert D. Galliers and Mari-Klara Stein (London: Routledge, 2017), 253–75.

15 Ingo Braun and Bernward Joerges, "How to Recombine Large Technical Systems: The Case of European Organ Transplantation," in *Changing Large Technical Systems*, ed. Jane Summerton (Boulder: Westview Press, 1994), 25–51.

16 See, for instance, Al Gore, "The National Information Infrastructure: Agenda for Action" (1993), 58 Fed. Reg. 49025–01, 1993 WL 365171 (Sept. 21, 1993); the National Information Infrastructure Act (1993); and the Bangemann Report on *Europe and the Global Information Society* (1994).

phrase put out by policymakers and research funders, the term was taken up and theorized primarily in the context of sociological research accompanying software development projects in the area of distributed computing. The research of sociologists of technology Susan Leigh Star and Karen Ruhleder has proven foundational for what is now known as infrastructure theory. In the 1990s, Star and Ruhleder conducted an ethnographic study about the construction of a digitally networked information system for biologists (a.k.a. the worm study). In the course of their research, they observed that the ideas about how the system should be conceived and what it should be able to do diverged quite sharply between the designers and the intended users. Star and Ruhleder took these conflicting views and experiences as a prompt to think about infrastructure "relationally," that is, not as technologies as such but as resources in relation to concrete actors' groups and "communities of practice."[17] Just as Bruno Latour claimed that a network is local at all its points, Star and Ruhleder's account of infrastructure and its meaning appeared as fundamentally situated and actor-related.[18] From the material collected in their ethnography, Star and Ruhleder distilled eight features that they believed illustrated such a relational understanding of infrastructure. As Christine L. Borgman synthesizes in an article,

> Star and Ruhleder are among the first to describe infrastructure as a social and technical construct. Their eight dimensions can be paraphrased as follows: An infrastructure is *embedded* in other structures, social arrangements, and technologies. It is *transparent*, in that it invisibly supports tasks. Its *reach or scope* may be spatial or temporal, in that it reaches beyond a single event or a single site of practice. Infrastructure is *learned as part of membership* of an organization or group. It is *linked with conventions of practice* of day–to–day work. Infrastructure is the *embodiment of standards,* so that other tools and infrastructures can interconnect in a standardized way. It *builds upon an installed base,* inheriting both strengths and limitations from that base. And infrastructure *becomes visible upon breakdown,* in that we are most aware of it when it fails to work—when the server is down, the electrical power grid fails, or the highway bridge collapses.[19]

To say that Star and Ruhleder were "among the first to describe infrastructure as a social and technical construct" may seem a bit misleading, if not unfair, given, for instance, the rich history of research on large technical systems and especially the fact

17 Susan Leigh Star and Karen Ruhleder, "Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces," *Information Systems Research* 7, no. 1 (1996): 111–134, 112, https://doi.org/10.1287/isre.7.1.111.

18 See Bruno Latour, *We Have Never Been Modern*, trans. Cathrine Porter (Cambridge: Harvard University Press, 2012), 117–119.

19 Christine L. Borgman, *From Gutenberg to the Global Information Infrastructure: Access to Information in the Networked World* (Cambridge, Mass: MIT Press, 2000), 19. Italics original.

that the major take-away of LTS research had already been the assertion that "'technology' is not only socially shaped [but] social through and through."[20] What distinguishes the approach of Star and Ruhleder, as well as subsequent scholars, from LTS research, however, is a strong focus on the micro-level of social interaction and, relatedly, a heightened attention to the local contexts of infrastructure development and the lived experience of diverse social groups.

As a sociologist of technology whose thinking was strongly influenced by feminist and critical theory, Star was particularly driven by the question of how technologies and the design choices that went into them affected people's concrete everyday lives and what kinds of inequalities they produced among different populations. By referring, for example, to Langdon Winner's seminal article "Do Artifacts Have Politics?," Star repeatedly pointed out that while infrastructures may act as helpful "bridges" for many, they might equally present obstructive "barriers" for some.[21] It is on this sensitivity to social and cultural difference that Star and Ruhleder argue that in studying infrastructure one must ask "*when* (i.e., under which conditions)—not *what*—is an infrastructure?"[22] Throughout her career, Star would repeatedly emphasize the relational nature of infrastructure, developing it into a form of infrastructural critique, for example, by addressing how mobility infrastructures such as steps and stairs can be both embraced and overlooked by many people, but "for the person in a wheelchair, the stairs and doorjamb in front of a building are not seamless subtenders of use, but barriers. One person's infrastructure is another's topic, or difficulty."[23] Star and Ruhleder's understanding of infrastructure thus unfolds less as a meso-level perspective on infrastructural systems, as has typically been pursued in media history and LTS research (among others), but more on the micro-level of ethnographic observation with a focus on diverse social actors and their contexts of practice related to the infrastructure in question. Consequently, this perspective led to a shift of focus from the development and "success" of individual infrastructural systems to different communities of practice and their respective relations to and within a system, such as the incompatibilities between the assumptions and practices of various stakeholders involved in the system (such as developers' assumptions about future users versus the actual needs and interests of different user groups).

Important contributions to this praxeologically oriented understanding of infrastructure were made not least by Star's partner Geoffrey Bowker. In fact,

20 Paul N. Edwards, "Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems," in *Modernity and Technology*, eds. Thomas J. Misa, Philip Brey, and Andrew Feenberg (Cambridge, MA: MIT Press, 2003), 185–225, 199–200.

21 Susan Leigh Star, "The Ethnography of Infrastructure," *American Behavioral Scientist* 43, no. 3 (December 1999): 377–391.

22 Star and Ruhleder, "Steps Toward an Ecology of Infrastructure," 113. Italics original.

23 Star, "The Ethnography of Infrastructure," 380.

Bowker had already used the term infrastructure to explain his historiographic approach in his book *Science on the Run* (1994) about the history of Schlumberger Corporation (SLB), which became the world's largest oil exploration company and offshore drilling contractor. In his book, Bowker advances the argument that it was not the supposed scientific and technical superiority of the oil exploration technology developed and marketed by Schlumberger that contributed to the company's sustained success, but rather the skillful and intensive personal networking of the company's founders and the acquisition of detailed information about local conditions:

> Schlumberger's chief means of strategic consolidation and scientific development was infrastructural work. By this I mean the set of techniques (administrative, social, and technical) that the company marshaled in order to get to work in the vicinity of an oil field. I will develop the position that this set of techniques preceded, created the conditions for, and determined the form of Schlumberger's science.[24]

This "infrastructural work" performed by actors to secure influence in a particular local environment and thus create or develop their own "infrastructure," takes place primarily behind the scenes and serves to put the actors in a better position to achieve their goals.[25] Bowker articulates his approach in the methodological concept of "infrastructural inversion," which encourages us to examine less the visible or exhibited practices of actors, and more the practices and circumstances in the background that enable actors to do or achieve what they do in the first place.[26] Bowker's use of the term infrastructure to mark resources for personal action and the practices of acquiring them thus contributed significantly to the rather radical, actor-centered reinterpretation of the concept. In the co-authored article "How to Infrastructure" from 2002, Bowker and Star further developed this new understanding of the term by conceptualizing it in its verb form "to infrastructure" as a *practice of in-*

---

24 Geoffrey C. Bowker, *Science on the Run: Information Management and Industrial Geophysics at Schlumberger, 1920–1940*, Inside Technology (Cambridge: MIT Press, 1994), 10.

25 The concept of "infrastructural work" here is thus somewhat different from that of, for example, Schabacher, who uses the notion "infrastructure work" (*Infrastruktur-Arbeit*) to consider the work *of* and *on* infrastructures (in a more classical understanding of the term). Rather, it seems to transfer Michael Mann's concept of "infrastructural power" from the macro scale of nation states to the meso scale of corporate actors. See Gabriele Schabacher, *Infrastruktur-Arbeit: Kulturtechniken und Zeitlichkeit der Erhaltung* (Berlin: Kulturverlag Kadmos, 2022), 9; Michael Mann, "The Autonomous Power of the State: Its Origins, Mechanisms and Results," *European Journal of Sociology / Archives Européennes de Sociologie* 25, no. 2 (November 1984): 185–213, https://doi.org/10.1017/S0003975600004239.

26 Bowker, *Science on the Run*, 10.

frastructuring that emanates from both individual and collective actors.[27] Infrastructuring, then, represents a rather fundamental everyday practice: Since all humans pursue goals in one way or another and often encounter obstacles along the way, in principle each of us—consciously or unconsciously—is "infrastructuring" everywhere and all the time. This conceptualization, as well as the approach of "infrastructural inversion," thus encourages writing historical developments as histories of "infrastructuring."

Star and Ruhleder's observation that the work of software development performed in the context of IT projects often consisted of the modular assembly of already existing elements and components, such as hardware, software, technical standards and protocols etc., further led to the realization that the users of these already existing "installed bases" were not only provided with practical advantages, but also with restrictions or path dependencies. In addition, the developers' assumptions about later users were reflected in the digital objects, for example, through preliminary decisions and classifications made in the context of the prestructuring of databases, which were usually adopted unquestioningly or without reflection. As a rule, these anticipations have had and continue to have normative effects that interfere with the user experience of non-normative users, simply because developers tend to assume tech-savvy, able-bodied, middle-class users as a default.

In their co-authored book *Sorting Things Out* (1999), Star and Bowker continued this line of research by critically examining mundane categorizations and rubrics found in, for instance, medical history forms, the gender assignments of public toilets, or the table of contents of the Yellow Pages. Not only are classifications ubiquitous, but the "categorical saturation furthermore forms a complex web"—a symbolic infrastructure that both supports and governs processes and practices through the indirect exercise of power and normativity.[28] Because of these political implications of supposedly banal everyday categories, Star and Bowker's infrastructure theory emphasizes the need to address the agency of the mundane and seemingly taken-for-granted.[29] Due to their consisting of data structures, the relevance and

27 Susan Leigh Star and Geoffrey C. Bowker, "How to Infrastructure," in *Handbook of New Media: Social Shaping and Social Consequences of ICTs*, eds. Leah A. Lievrouw and Sonia Livingstone (London: Sage, 2002), 151–162. The notion was later taken up in the field of socio-informatics. See Volkmar Pipek and Volker Wulf, "Infrastructuring: Towards an Integrated Perspective on the Design and Use of Information Technology," *Journal of the Association of Information Systems (JAIS)* 10, no. 5 (2009): 306–32.

28 Geoffrey C. Bowker and Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences* (Cambridge: The MIT Press, 2000), 38.

29 In 1997, Star half-jokingly co-founded "The Society of People Interested in Boring Things" in Palo Alto. Her interest in the politics encapsulated in seemingly dull and mundane objects later led to a collective volume co-edited together with Martha Lampland on standards,

consequences of "classification work" are particularly relevant with regard to digital objects and processes.[30] Applied to the development of networked applications and services on the Internet, this perspective thus prompts us to scrutinize not only the functionality but the socio-cultural dimension and cultural-political implications of technological objects and applications, and in particular the dynamics of normalization and marginalization that emanate from them.

3. Some Methodological Implications of Infrastructural Thinking in Media Studies

The concept of infrastructure coined by Star, Ruhleder, and Bowker—with its consideration of actors groups, its interest in the everyday and the taken-for-granted, and its sensitivity to the normalizing and marginalizing effects of technological configurations—has been taken up and further developed in various disciplines within the social and human sciences, including STS, urban studies, anthropology, and literary studies (some of these developments have been touched on in the introduction to this volume). Since a detailed account of them would exceed the scope of this paper, I would like to end by focusing on a central aspect of infrastructural thinking to discuss some of the methodological implications it has had for the study and historiography of media. This aspect consists primarily in the paradoxical fact that the preoccupation with infrastructural theory has drawn scholarly attention away from technical *systems* and operations to the importance and variety of human (and non-human) *practice*. This praxeological shift has equally affected both the study of contemporary media and the writing of its history and seems to yield new methodological possibilities for future research in other humanities disciplines too.

Drawing on earlier STS work, for instance, Steven J. Jackson suggested in his 2014 article "Rethinking Repair" that media studies should not only focus on technological innovation, but also consider more closely the labor of maintenance and repair, a call that was echoed shortly thereafter in studies of media infrastructure and the history of computing.[31] In *The Undersea Network*, Nicole Starosielski uses a

---

which in turn inspired media scholars to interrogate the assumed neutrality of technical norms and specifications, such as color cards used in photography or the MP3 format, within the history of media. Martha Lampland and Susan Leigh Star, *Standards and Their Stories: How Quantifying, Classifying, and Formalizing Practices Shape Everyday Life* (Ithaca: Cornell University Press, 2009); Lorna Roth, "Looking at Shirley, the Ultimate Norm: Colour Balance, Image Technologies, and Cognitive Equity," *Canadian Journal of Communication* 34, no. 1 (2009); Sterne, *MP3*.

30 Bowker and Star, *Sorting Things Out*, 1.

31 See, for instance, Tarleton Gillespie, Pablo J. Boczkowski, and Kirsten A. Foot, eds., *Media Technologies: Essays on Communication, Materiality, and Society* (MIT Press, 2014); Andrew Rus-

similar focus on site-specific labor and everyday practices to tell the story—or rather stories—of the Pacific submarine cable network in a different way. Focusing on the diverse practices of managers, cable workers, local residents, politicians, and researchers at distinct sites or "nodes" (such as cable stations, cable landings, or islands), Starosielski shows where cable infrastructure intersects with and how it is "grounded" in physical, sociopolitical, and cultural environments through strategies of "insulation" and "interconnection."[32] Based on this praxeological perspective, Starosielski argues that global signal traffic is as much rooted in people (in terms of "human labor and embodied experience"[33]) and their respective practices of "infrastructuring" as it is in the material and technological components of the cable network.

A similar focus on practices is mobilized by John Durham Peters in his book *The Marvelous Clouds*, in which he pairs infrastructure theory with German and French cultural techniques research to forge a doctrine of "infrastructuralism." According to Peters, "infrastructuralism suggests a way of understanding the work of media as fundamentally logistical."[34] In particular, present-day digital media do not only integrate aspects of the "old" mass media, but also "resurrect old media such as writing, addresses, numbers, names, calendars, timekeepers, maps, and money [and] give new life to age-old practices such as navigating, cultivating, stargazing, weather forecasting, documenting, and fishing."[35] By centering the "logistical" and cooperative role of media and the history of their invention and development within the scope of quotidian practices and cultural techniques of "recording, transmitting, and processing culture; of managing subjects, objects, and data; [and] of organizing time, space, and power," Peters ultimately argues that "media serve more as devices of tracking and orientation than in providing unifying stories to the society at large" and that we should therefore understand them more generally as "infrastructural media" in the sense of "media that stand under."[36]

Attention to everyday strategies of "infrastructuring" also foregrounds new practice-oriented stories of media change and technological transformation. The recent boom in video conferencing applications at the onset of the global Covid-19 pandemic is a particularly striking example: Rather than being fuelled by the potential of new media practices based on technological innovation, billions of people affected by lockdowns and measures of "social distancing" turned to remote

---

sell and Lee Vinsel, "Hail the Maintainers," *Aeon*, 2016, https://aeon.co/essays/innovation-is-overvalued-maintenance-often-matters-more; Parks and Starosielski, *Signal Traffic*.

32 Nicole Starosielski, *The Undersea Network* (Durham: Duke University Press, 2015).

33 Starosielsk, *The Undersea Network*, 98.

34 John Durham Peters, *The Marvelous Clouds: Toward a Philosophy of Elemental Media* (Chicago: University of Chicago Press, 2015), 37.

35 Peters, *The Marvelous Clouds*, 8.

36 Peters, *The Marvelous Clouds*, 7, 19, 33.

technologies, and particularly video conferencing, to "re-infrastructure" collapsed routines of everyday cooperation that had previously taken place in shared spaces such as offices, classrooms, or gyms.[37] A significant part of this re-infrastructuring work involved processes of appropriating video conferencing tools and adapting them to one's own needs, existing contexts of practice, and related social expectations, for example by redecorating or otherwise staging the domestic space visible to the camera during video calls, by acquiring new technological devices such as ring lights, or by reading (or even writing) one of the numerous "guides" aimed at teaching (and thereby normalizing) user behaviour for "successful" Zoom calls. In this light, infrastructuring appears as a two-way process: On the one hand, the new users of remote technologies and video conferencing applications had to adapt to the functionalities of the existing solutions; on the other hand, the providers of products, such as Zoom, also reacted to the specific needs of the new user groups, by, for instance, incorporating new functionalities or different workflows.[38] The general practice of quotidian infrastructuring can thus be understood as a process of mutual adaptation and harmonization of media (including technologies and other elements related to their use) and sets of already existing practices, a dynamic which can complement provider-oriented accounts of traditional media history.

Moreover, the public discourse that accompanied the mainstreaming of video-conferencing applications also revealed on-site practices as the social norm prior to the pandemic. To give an example, many people with disabilities used the hashtag #AccessibilityForAbleds created by Canadian disability activist Kate McWilliams to express their frustration about the fact that the shift to remote practices at the beginning of the pandemic was accomplished in just a few weeks when it affected the abled-bodied majority, while the demands for opportunities to participate remotely in work or educational activities often voiced by people with disabilities had not been heard for years. The example of videoconferencing thus points to the normativity inherent in the general development of technology, which tends to neglect—and thereby potentially exclude—user groups outside the boundaries of the implicit norm that is both consciously and unconsciously considered to be the default. This inherent bias extends to the historiography of media, too. It is striking, for instance, that Deaf people are rarely featured in the history of video telephony and video conferencing, even though their use of sign language makes them an ideal

37 Axel Volmar, Charline Kindervater, Sebastian Randerath, and Aikaterini Mniestri, "Mainstreaming Zoom: Covid-19, Social Distancing, and the Rise of Video-Mediated Remote Cooperation," in *Varieties of Cooperation: Mutually Making the Conditions of Mutual Making*, eds. Clemens Eisenmann, Kathrin Englert, Cornelius Schubert, and Ehler Voss, Media of Cooperation (Wiesbaden: Springer VS, 2023), 99–133.

38 See Volmar et al., "Mainstreaming Zoom"; Axel Volmar, Olga Moskatova, and Jan Distelmeyer, eds., *Video Conferencing: Infrastructures, Practices, Aesthetics* (Bielefeld: transcript, 2023).

demographic for visual communications technologies. A closer look at the history of media use from the perspective of non-normative user groups reveals that the normalizing effects inscribed in media technologies cause further marginalization in terms of lesser options for use and participation when compared to standard users because the technologies are simply not conceived *for* them but for people with other bodies and abilities. The insights into the significance of practices of non-normative infrastructuring has led, for example, to new alliances and academic exchanges between media studies and disability studies, as evidenced, for example, by the academic network "Dis-/Abilities and Digital Media," funded by the German Research Foundation.[39] An actor-centered focus on infrastructure that critically engages with the normativity of the supposedly universal *standard user* can thus help us to both produce richer and more diverse histories of media and the people who use them, and to advocate for a more inclusive media infrastructure in the future.

Conclusion

As I attempted to show in this brief conceptual history, the term "infrastructure" is much more than just another synonym for a technological system, network, or platform. Rather, the nuanced notion of infrastructure developed within the sociology of technology invites us to ask what kinds of normalized preconceptions and uses are inscribed in technological, institutional, symbolic, and other everyday resources, and thus which user groups are implicitly supported in carrying out their everyday practices and which are not. The term thus encourages us to reconsider traditional objects of humanities research in relation to the lived experience of different actor groups in order to unveil their inherent politics.

In terms of methodology, an infrastructural or infrastructuralist perspective suggests that we no longer look at only existing infrastructural systems but take different actors groups and their respective infrastructural needs and practices as a starting point for scholarly investigations. Obtaining a praxeological and situated understanding of infrastructure, which centers actors first before determining what may or may not count as an infrastructure in relation to these actors, is not least a politically motivated shift of the analyst's attention used to identify infrastructurally underserved and disadvantaged populations and to understand practices of "infrastructuring." This fact seems to escape some of the current critics of the infrastructure concept, whose understanding often still assumes infrastructures to be existing and clearly defined objects or services of some kind.

39 See "Scientific Network Dis-/Abilities and Digital Media," accessed August 29, 2023, https://dis-abilities-and-digital-media.org/index.php/en/project.

This shift in the focus of scholarly attention from infrastructures in the common sense of the term to actor-centric support infrastructures, however, often remains implicit in the discourse of current infrastructure research. Thus, the danger of "vagueness" that can accompany the use of the concept of infrastructure, as criticized by Hesmondhalgh for example, is certainly present. In the context of one's own work, it is therefore advisable, of course, to clearly indicate what understanding of infrastructure one is relying on. Rather than overstress the necessity for clarity when defining the notion of infrastructure, we should, however, focus more on emphasizing the *purpose* of using the concept in the first place. Or, put differently: the pressing question today seems to be not so much how exactly we define infrastructure but how an infrastructural perspective can change the ways scholars in the humanities actually work and how they present their research. Of course, studies of infrastructures within the humanities can continue to start from technical systems and other geographically distributed installations. The shift from an systemic to a praxeological understanding of infrastructure invites us, however, to account for infrastructure's relationality due to the social, cultural, spatial, and other differences among its various stakeholders, the politics and cultural-historical significance of the taken-for-granted, and the everyday practices of "infrastructuring." At the very best, an infrastructural perspective could help us to look at familiar themes with fresh eyes and ultimately to create more context-sensitive and diverse stories.