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Thinking relationally about digital inequality in rural regions of the U.S.

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Abstract

This article reconsiders the concept of digital inequality drawing from recent developments in science and technology studies, including evolving theories of materiality (Barad, 2003; Bennett, 2010; Ingold, 2012), work on critical media infrastructures (Parks and Starosielski, 2015), and on maintenance and repair (Jackson, 2014; Edgerton, 2007). New ways of thinking about the material world move away from an examination of the cultural significance of 'objects' to consider the relationality, vibrancy, and continual "becoming" of materials that we live amidst and interact through. These innovative theoretical developments offer new ways of framing present-day problems and consequences of disparate connectivity by drawing attention to connecting infrastructures instead of the end points of access. I draw from ethnographic fieldwork on Internet access and use in a rural and remote part of northern California to show how the uneven and patchy deployment of the Internet and its physical infrastructures across space shapes rural experiences of the Internet.

Contents

Introduction

Social inequality is a core sociological concern. One way that scholars diagnose inequality is by examining how a resource (tangible or intangible) is distributed across a population and how this comes to determine an individual's socio-economic standing. Studies of inequality consider the potential for individuals and groups to improve their position, the avenues they pursue to do so, and the structural barriers that stand in the way. For social scientists who study computers and network technologies, digital inequality marks a set of related but distinct questions. Does access to a computer and the Internet improve one's chances for upward social mobility? As the U.S. economy shifts toward service and information sector work, is digital literacy necessary to maintain one's standing (DiMaggio, et al., 2004; Hargittai, 2008)?

Scholarship on this topic has moved beyond a narrow, binary notion of the 'digital divide,' of Internet 'haves' and 'have-nots.' [1] There is now a better understanding of how quality of access (i.e., time-limited shared use facilities vs always-on at-home connections, mobile phones vs. laptop computers) plays into how much users benefit (Donner, 2015; DiMaggio, et al., 2004; Robinson, 2009). Lenhart and Horrigan (2003) characterize access not as a binary state, but as a 'spectrum' noting that non-use can be voluntary, and that the relevance of the Internet may also be unclear to some prospective users. It is also now well recognized that while access to a computing device and a network connection is one part of the problem, acquiring the skills to make use of such a resource is also critical (DiMaggio, et al., 2004; Hargittai, 2008; Livingstone and Helsper, 2007; Schradie, 2012, 2011; Warschauer, 2003).

The literature cited above, at its foundation, considers digital inequality to be the uneven distribution of network connectivity (and/or the skills to use this resource) across populations. Other approaches diverge further from this basic framing. Eubanks (2011) argues that a distributive justice approach to digital inequality misidentifies the problem and that such an approach is contradicted or even vocally refuted by those in socio-economically marginalized groups. In her study of low-income women in Troy, N.Y. they described encounters with computer systems in social services offices where they were an unimpeachable authority or a tool of surveillance or in jobs where computers were tools of low-wage labor (such as call center work). Gangadharan (2012) similarly points out that online 'inclusion' in digital worlds is not an unmitigated gain as it can expose minority and marginalized populations to surveillance. As incorporation into network systems becomes inescapable for most people, this work suggests that the potential for harm must be taken seriously.

Another literature on municipal wireless networks and other types of community networks looks not at the demographics of access, but instead explores how localized collectives critique the assumption that connectivity provisioning is, or ought to be, a free market pursuit. These collectives self-organize to build, redesign, or repurpose infrastructure (Jungnickel, 2014; Ortiz and Tapia, 2008; Sandvig, 2012a, 2012b). Along similar lines new work in critical media infrastructures notes that media messages and information flows are shaped not just by powerful content creators, but by the structure of the channels that content flows through (Parks and Starosielski, 2015). They point to the way infrastructure is made intentionally invisible. As a consequence, citizens lack knowledge about where it is and how it functions. This work proposes another way to question (digital) inequality looking to the policies and practices that bring about the material foundations of the network. Along with the municipal Wifi and DIY infrastructure work, this body of scholarship fits into a separate thread of inequality research, what Yu (2011) labels the political economy of information. This approach focuses not on the demographic patterns of access, but the power struggle between consumers/citizens and corporations in which the former are often deeply disadvantaged.

Drawing from fieldwork on Internet access and use in a rural and remote part of northern California, I focus on problems related to the overall intensification of connectivity nationally. I argue that poor Internet connectivity is not simply a 'natural' consequence of the demographics of rural areas where residents tend to be lower income, possess lesser educational attainment, and are older in age. It is a matter of exclusion. This exclusion is shaped by geography, remoteness, and population density which are consequential within a particular American political economy where the availability of connectivity is largely market-driven.

With the rise of pervasive expectations of connectivity, I argue digital inequality is better understood as relational and, more specifically, as marked by center-periphery relationships. Such an approach is most aligned with social exclusion theories of information inequality which "see society as an evolving social plane, with some at the centre and some at the margin" (Yu, 2011). In what follows I show specifically how network connectivity infrastructures, as produced by corporate entities and leveraged by those well placed in network centers, excludes those in the rural margins. In turn, those residing in these margins develop workarounds seeking ways to overcome this material exclusion. They do so with mixed success.

The relational character of digital inequality is evident in three key observations drawn from my fieldwork on rural connectivity. First, I note that what rural residents typically experience is not a state of being either on or off the Internet, but of being intermittently and unpredictably connected. I describe this problem as the instability of the network. While attention is most often paid in digital inequality scholarship to the endpoints of access (the network connected device, shared access facility, and users) a relational sensibility directs attention upstream to the Internet's infrastructure; the cables crisscrossing landmasses and running beneath the oceans, the wireless signals from antennas mounted on towers, and the placement of satellites orbiting the planet. A new literature examines the way the Internet is materially manifested in data centers, fiber optic cables, and Internet exchanges (Farman, 2014; Starosielski, 2015; Hogan, 2015; Dourish, 2015). Experiences of network instability raise questions about where infrastructure is located, what investments have been made (or not made) in its redundancy, and in processes to maintain and repair it.

Secondly, while we have referred to 'the Internet' at least since the 1980s by a singular term, this belies the dramatic changes to the Internet's underlying standards, platforms, and content. Critical recent changes to the Internet include the shift to software as a network-delivered service, Web apps like Google docs, automatic software updates, embedded streaming media, cloud backup services, and generally, a creeping increase in the data demands that content and service providers place on the network connections of users. The ways in which the complex assemblage we call 'the Internet' has changed over the past few decades exacerbates disparities between the well and poorly connected. This is a problem of who the changing Internet leaves behind. For example, in rural communities, some residential Internet subscribers continue to hold on to a type of obsolete connection (such as ISDN or dial-up) that no longer functions adequately to handle the demands of the present-day Internet and is no longer actively supported by service providers.

Finally, the Internet constitutes an interactional space that structures relationships amongst users. The Internet is not merely a channel for distributing content, but a communication system that connects people who are very differently situated geographically and socio-economically (Burrell, 2012). Platform builders, content distributors, and standards-setting bodies (generally operating from urban environments) are particularly influential in structuring and setting expectations for use. A relational sensibility draws attention to the asymmetrical power relations between users. I describe this as the problem of how connectivity expectations are imposed from network centers.

The Internet in the United States is now at a late stage of technology adoption. This is, in part, what necessitates a reconsideration of how we frame "digital inequality." The near ubiquity of the Internet comes with a rising expectation that everyone has access to it. Claude Fischer, in his social history of the telephone, documents how the growing adoption of that technology led to its transition from luxury to necessity. He documents how a technology's utility and necessity is redefined over time as alternative tools and systems that were once relied on disappear and as social expectations and the embedding of the technology in various institutions make it increasingly inconvenient to remain a non-user (Fischer, 1992). Non-users generally cannot fully extricate themselves from dominant technological regimes, they can only partially opt-out (Wyatt, 2003). A few examples of a general intensification of the pressure to be connected in rural areas include: schools assigning Internet-based homework, the disappearance of local bank branches with the rise of online banking, and businesses offering Internet-only customer service. These point to a new reality, one where connectivity is an implicit requirement for participating in commerce and public institutions.

Internet users in a remote area of Mendocino County, California experience persistent disadvantage due to their lack of quality Internet. They also engaged in a wide range of strategies to manage connectivity from their peripheral position. Rural residents take on an extra burden of labor, time, and expense to meet the data and bandwidth demands that evolving applications of the Internet now impose and require. Some strategies, such as launching an independent ISP, follow a long tradition of rural self-reliance and self-provisioning (Kline, 2000). Rural infrastructures also become more visible as rural residents use various means to expose them to public scrutiny, for example, through local newspaper reporting and by calling for public hearings.

Site and method

The specific site of this research is a coastal region of Mendocino County in California where residents are engaged in an ongoing struggle to gain and maintain quality Internet connectivity. It is a periphery but in relatively close proximity (a drive of three to four hours) to the world's preeminent network center, Silicon Valley. Notably, the area hosts critical elements of the core infrastructure of the Internet. In the Cold War period, a cable landing station was relocated from San Francisco to tiny Manchester, Calif. (population 195 in 2010) as a security measure. This cable landing station initially connected the U.S. and Japan with international telephone and telegraph service. Coaxial cables were replaced in the early 1990s with fiber optic cable which provide Internet backhaul capacity, transferring data to Sacramento, San Francisco, and other urban centers. However, until very recently, these cables provided little to no local access. The national incumbent ISPs (like Comcast and AT&T) do not prioritize broadband needs in this area where providing infrastructure is cost prohibitive, however areas like coastal Mendocino County are the target market for satellite Internet services. Rural areas are also often served by small independent, privately owned ISPs.

The corpus I analyzed consisted of transcripts of a range of speech forms. In one-to-one interviews and group meetings, I guided the speech that was produced through my line of questioning. Some speech performances I observed without directing. This latter category constitutes things said publicly about the Internet; for example, at in-person events such as meetings of a local broadband advocacy group, and on local radio station programming.

In total I carried out 61 one-on-one (and a few one-on-two) interviews with people who live in or have ties to the area. Most were carried out in-person, some by video call or phone. The focus of most interviews was on hearing Internet access histories, patterns of use, and how interviewees perceive their dependency on Internet connectivity. Most interviews were also audio-recorded for the purpose of generating a high-fidelity transcript. My recruiting strategy targeted people who are reliant on connectivity or in other ways invested in realizing better connectivity in the area. Consequently, I make no strong claim for typicality, only for recurrent themes. Many interviewees were invested in connectivity by virtue of their profession. These interviewees were involved in information or media fields, such as newspaper publishing and local radio, or were employed as software engineers or educators. I also made efforts to reach out to various groups that were characteristic of the rural region, but who did not necessarily have a vested interest in good Internet connectivity. This included groups defined by livelihood, such as those working in agriculture or the fishing industry, and culturally identified groups, including Native Americans of the Pomo Indian tribes and the growing Latinx population.

To analyze the data, I used MaxQDA qualitative coding and analysis software. I generated a code system of 41 codes through an inductive coding process informed by grounded theory procedures (Charmaz, 2006). The foundation of the argument of this article draws primarily from data coded with three frequently recurring codes. First, a "developing workarounds and strategies" code that dealt with ways Internet users managed poor and intermittent connectivity. This code was applied to 26 segments of data. Secondly, a "being/becoming infrastructurally aware" code that included discussion or commentary about the infrastructures of Internet connectivity. This code was applied to 39 segments of data. Thirdly, a "perceiving

one's marginality" code that documented contrastive experiences, generally between urban and rural settings. This code was applied to 64 segments of data. These three codes appeared at least once in 30 separate documents in the corpus and encompass much of the data quoted in this article.

The instability of the network

Rural residents often experienced network connectivity as something that they could not rely on. Many reported the quality of their connections fluctuated severely throughout the day or sometimes went down altogether. Outages occurred as often as every few days or every week. Patterns of instability were sometimes seasonal: weather and periods of high tourism all played into the quality of connectivity. As a result of the instability of their connections, many rural residents thought about the Internet explicitly in terms of its physical composition. In coastal Mendocino County, residents spoke in nuanced ways about the qualities of their connection that could be characterized not only by its throughput speed, but also network latency, data allowances, reliability, and cost. Where connectivity was scarce or unreliable, some rural residents came to recognize, describe, and attach meaning to the physical manifestation of the Internet; its, wires, poles, towers, antennas, and orbiting satellites. Residents described to me how many feet one had to be from a central office to get decent DSL service, how to recognize aerial fiber optic lines (by the loops of slack cable used to patch breakages), and the corrosive effect of seawater on cables buried without the protection of a conduit. Their descriptions were not always accurate and their theories explaining connectivity issues could be implausible, but such commentary nonetheless reflected a need to locate and materially manifest the 'digital' as a way to grapple with their struggle to obtain or maintain access.

To make sense of these observations I take a materialist approach. This means that the particularities or properties of the material world, such as these details of infrastructure highlighted by my interviewees, are considered for their potential to shape social outcomes. The theoretical 'trick' in such a materialist analysis is to avoid succumbing to technological determinism. While historically matter has been equated with objects (and sometimes as only that which is 'man-made'), more recent theoretical developments have sought to undo these habits of thought. Actor-network theory offers a "relational materiality" (Law and Hassard, 1999) arguing that our everyday understanding of 'objects' is instead an effect of a particular arrangement of composing entities, an assemblage. These assemblages require constant performance to accomplish their apparent stability. In keeping with this renewed analysis of matter, Barad (2003) argues for phenomena as the unit of analysis in her materialist philosophy stating that "matter is not little bits of nature" it is "not a thing, but a doing." Ingold (2012) and Bennett (2010) tackle the implied stasis underlying notions of the material-as-object arguing for the vibrancy and vitality of matter. Relating this new materialist approach to questions of network connectivity brings time back into consideration. To be connected is not to possess a connection (reified as an object); connectivity is rather a state in constant fluctuation and is only experienced as stable under special and privileged circumstances.

The experiences of rural users in Mendocino County suggests that the current state for many marginal rural markets that are connected to the Internet is, at best, a provisional stability. This is the kind of site Jackson (2014) suggests can be approached through "broken-world thinking," a new mode of investigation aligned with new materialist thinking. The fragility of rural connectivity, however, is not distinguishable as either technical/material or social. Satellite, for example, is far from an optimal connection, notable for its high latency due to the long journeys data packets must take, traveling to near outer space and back. This makes the experience of certain uses of the Internet (especially networked gaming and synchronous or streaming video) less than optimal. However, other instabilities stem from 'soft' infrastructures; the way small, local businesses operate, for example.

Small rural ISPs sometimes close down, sometimes quite abruptly. For example, in recent memory, an ISP called Esplanade went dark Valentine's Day weekend in 2011. One area resident Clark who was critically reliant on Internet connectivity for his media production business, described it in an interview, "[Esplanade's] operations went up in smoke, disappeared ... there were people that were extremely dislocated by not having Internet." Luckily, just prior to the event, Clark had gotten some unsolicited advice from someone doing part-time work for the small mom-and-pop ISP. This person had warned him that he might want to subscribe to a secondary Internet service as a precautionary measure. He signed up with a local small cable TV provider that had just started offering Internet service. Reflecting on the personalities involved and commenting specifically on Esplanade's unpredictable owner he noted, "I didn't want to put all my eggs in [the ISP owner's] basket just because of the way he was ... . He was unstable and I think he had some personal issues too." A letter to the editor in the local newspaper written by the wife of the husband-and-wife team running the shuttered ISP acknowledged that the stress of running the business, marital problems, and mental health issues had become overwhelming for its owner [2]. Such individual and interpersonal challenges are much more likely to submerge a small business than a large corporate provider.

Incidences where fiber optic cables in the area were cut (snagged by a truck in one instance, by a misguided copper [3] scavenger in another) revealed the areas reliance on a single thin and non-redundant bandwidth pipe. Such outages demonstrated that much of the data passing into and out of the area was vulnerable to area-wide disruption at a single point of failure. They have also highlighted how disparate communication media rely on the same physical infrastructure in this remote county. Outages have affected not only Internet connections, but also landline and mobile phone service, ATMs, point-of-sale systems, and emergency communications [4]. This convergence is one reason why elected officials in the area along with

Broadband Alliance of Mendocino County (http://www.mendocinobroadband.org), a broadband advocacy group, participate in campaigns to preserve copper-based landline phone service. In moments of breakdown the reliance on legacy infrastructure is starkly revealed.

The campaign to preserve and maintain copper cables in rural regions complicates a linear, evolutionary model of technological advancement that positions new technologies as neatly displacing old obsolete ones. As an alternative to this evolutionary model, Edgerton (2007) advocates for an analytical approach that focuses on the study of technology-in-use, rather than on emerging technological innovations. This offers an alternate way of determining what technologies are of greatest significance against the tendency to examine those technologies that are most "culturally visible" or that accord with modernist notions of time and the march of progress. In particular Edgerton observes that new and old technologies continue to co-exist. Some technologies or techniques die down in use only to resurge later (for example, condoms, or organic foods). It is not the case, he points out, that new technologies are superior in every way to old ones or that we can or should expect the new to entirely supplant the old. This challenges a key assumption of technology diffusion, that it follows a predictable technological arc rising smoothly until it is displaced cleanly by its replacement (i.e., Rogers, 1995).

However, technological obsolescence is what lobbyists and company representatives have called upon in AT&T's campaign to divest from their legal obligation to maintain the copper infrastructure that provides landline service as well as some Internet connectivity [5]. Landline service becomes unnecessary and unsustainable, they suggest, as consumers shift to cell phone service. Accounts among Mendocino County residents counter the assumption of available alternatives to the copper infrastructure. They also show that AT&T has, at times, significantly delayed repairs to this infrastructure. For example, on a local radio show program on the rural digital divide broadcast on 20 February 2015, a 70-year-old resident called in to describe how her phone line had been cut off after a storm two months prior. Facing silence from AT&T customer service she eventually, "talked to a repair guy down at the bottom of the road. He said they have no plans to fix those lines ... . It does affect my dial up which I cancelled because I don't have a phone line. So I'm basically off the grid. I have a cell phone which I can use out on my porch where I get pretty good reception." In Mendocino County residents like this elderly woman still rely on the copper infrastructure; for phone service but also for Internet service (including DSL, ISDN, T1 lines, and even dial-up). It should be noted, the copper line infrastructure was installed in a different political era. It was supported by the 'New Deal' era federal programs of U.S. President Franklin Roosevelt. This was also a period when proportionally more of the country's citizens lived in rural areas.

Who the changing Internet leaves behind

In 2001 newly appointed FCC Chair Michael Powell, in response to a journalist's question about the 'digital divide,' stated, "I think there's a Mercedes divide. I'd like to have one. I can't afford one." At the time, only six percent of Americans had home broadband connectivity, so it was truthfully as exclusive as luxury car ownership. At that time, 41 percent of Americans had dial-up, and the remainder, over half the country, did not have a home Internet connection at all (Wormald, 2015). However, much has changed since then. By 2016 73 percent of Americans had a home broadband connection (Pew Research Center, 2018).

One standard way of visualizing progress on the 'digital divide' is through a technology diffusion graph. Such a graph shows the change year-by-year in how many people have adopted and are now using the Internet. There are a few problems with formulating this as a measure of the closing digital divide. First, it implies that the technological 'object' measured at time A is the same 'object' at time B. Yet, what constitutes the form and substance of the Internet (the things we can do when we are 'on the Internet' and the devices and platforms which support ways of doing them) has changed enormously since 2001. Significantly, it has changed in some specific ways that exacerbate disparities between the well and poorly connected. The Internet has also become deeply entwined with various institutions (education, government, healthcare) and processes within society. In the U.S., using or not using the Internet today has very different implications and consequences than it did a decade or two ago.

While residential broadband subscription rates in the U.S. have climbed, quality of access remains a key differentiator. Residents in rural areas in particular typically pay much more for lower quality Internet connections that not only offer lower throughput speeds, but also high latency (in the case of satellite Internet in particular), data caps, and recurrent problems with outages (Russo, et al., 2014). These quality differences are not routinely measured in major, national Internet access surveys, such as those carried out by the Pew Research Center or the 'Computer and Internet use' survey of the U.S. Census Bureau. Furthermore, the near ubiquity of connectivity has, over time, led to an increasingly entrenched assumption that everyone is connected and enjoys a certain level of quality in connectivity. This shapes the micro-dynamics of individual relationships mediated by the technology as well as interactions with companies and institutions.

Assumptions about a baseline quality of connection are also making their way into the more immutable material design of technology platforms. Today, software is a network-delivered service, Web apps like the Google documents suite require a network connection to use, as do automatic software updates, and cloud backup services. There is a creeping increase in the data demands placed on the network connections of users. To give one example, in 1995, the average Web page took three seconds to download from a 56.6 baud dial-up connection. In 2017, the average Web page

would take about seven minutes to download with that same connection (see Figure 1). On the Mendocino coast, approximately 250 residents still connect to the Internet via dial-up from a local ISP, Mendocino Community Network.

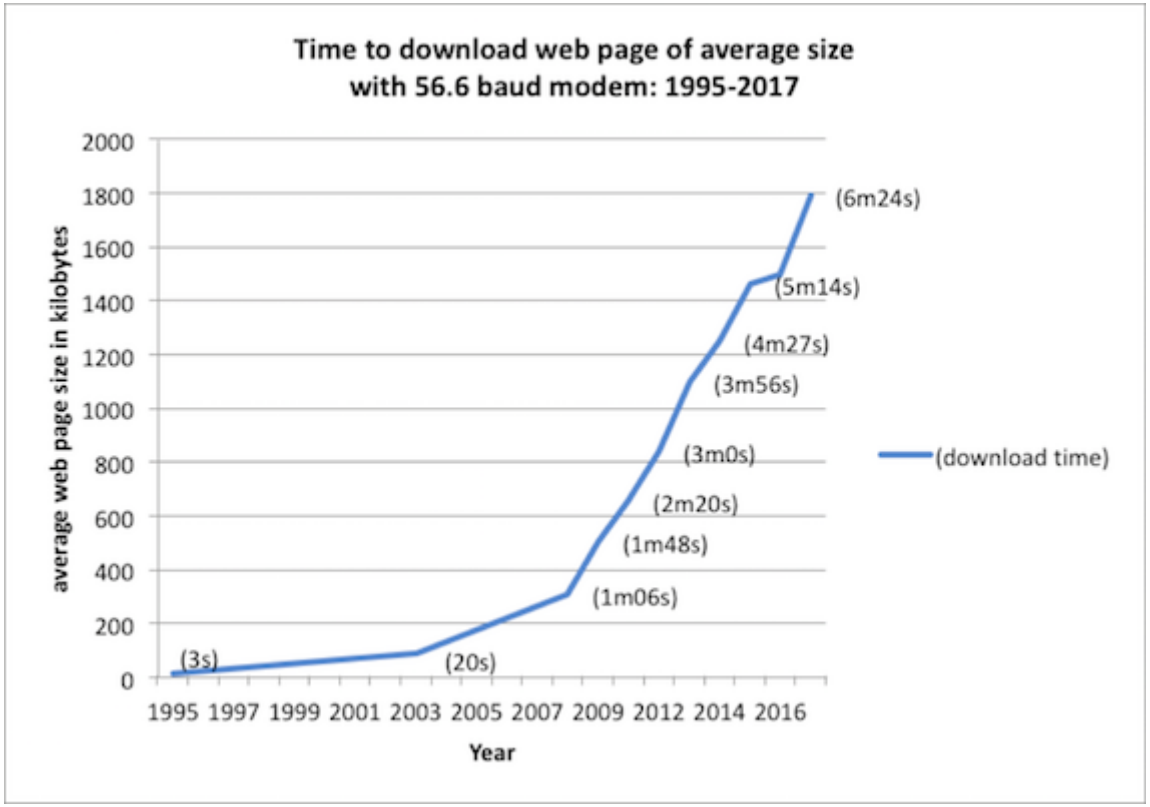

Figure 1: In 1995, the average Web page took three seconds to download using a dial-up connection with a 56.6 baud modem. In 2017, the average Web page took almost six and a half minutes to download with the same connection [6].

Note: Larger version of figure available here.

Connectivity expectations imposed from network centers

In coastal Mendocino County, poor connectivity is a shared experience due to the area's physical infrastructure. While fiber optic cables are abundant due to a nearby cable landing station which connects the West Coast of the U.S. to Japan, much of this capacity is locally inaccessible [7]. Furthermore, when rural users interact with the better connected, it is those at network centers who exert and structure expectations, often in ways that cannot be met (or at least not easily) by those who are poorly connected.

In rural sociology, dichotomous and categorical distinctions (between rural and urban) have been replaced by notions of interconnection and interpenetration that similarly reflect a newly relational approach (Woods, 2006; Lobao, 1996). Computer-based Internet connections as well as cell phone services are among the systemic links constructing a rural-urban interface (Lichter and Brown, 2011). Yet at this interface, interactions and their outcomes frequently reflect the powerful hegemony of network centers which are almost always urban. In interviews, I found that many residents, when talking about the Internet and connectivity in general, positioned their remote community in relation to the world beyond. They noted that staying connected was important for "being part of the world." Residents also spoke about connectivity in temporal terms, as a problem of 'keeping up,' or 'falling behind' or lamented that the, "world is zooming by."

Jett [8], a gregarious twenty-something had moved back to the community where he grew up on the Mendocino coast to regroup after a short stint working in startups in the Bay area and to help take care of his ailing mother. We met at the local co-op, a small grocery store with a café, eclectic tables, and worn seating arranged to take advantage of the sunlit storefront windows. At the co-op I noticed that nearly every person entering the store paused and turned to scan the entire café from one side to the other expecting to recognize someone there. Three or four stopped to talk to Jett, a widely recognized and well liked community member.

Jett described how, after moving back home, he had hoped to earn income by maintaining a couple of contract jobs doing multimedia design work. For his current contracts, he needed to download 10 gigabytes of files. At the time, no publicly accessible institutions offered sufficient Internet connectivity for this task. He drove up to Fort Bragg, the nearest mid-sized town, to try to download the files at Starbucks, but by a stroke of bad luck, their Internet connectivity was down. To add to Jett's difficulties, connections offered by the small cable company and satellite Internet providers serving the coastal area generally came with data caps of between 10–20 gigabytes per month. If he could find a generous friend who would allow him to download the assets from their residential connection, it would likely consume at least half of an entire month's data allowance, a huge imposition.

Jett reported to his client, "look, I can't download the assets." From his recollection their response was, "what are you talking about? What do you mean? How is that possible?" To drive home the point about the standard of connectivity in his rural locale, he responded, "I just had to drive 20 minutes just to text you, call you, or email you." In the end, he lost both contracts. After moving home and attempting to rebuild his life after a career setback, losing this work was, "really depressing." He concluded, "I couldn't navigate through the tech world being here." Jett's employer, clearly situated in a network center, met Jett's situation with incomprehension and inflexibility. In network centers, pervasive connectivity has led to rising expectations of immediacy and responsiveness. "Total availability" even beyond normal working hours is a signal of professionalism, especially in certain domains of elite service work (Mazmanian and Erickson, 2014).

This problem, however, did not afflict only telecommuters connected to the tech-industry. I met Melissa, a chef by trade, by walking into the small storefront where she sells jams and all other kinds of handmade preserves. She was clearly busy and told me so. We arranged a phone interview during one of her self-imposed 12-hour shifts so that she could multitask, talking while she was, "up to her elbows in peach juice." During our phone interview Melissa mentioned a friend, a photographer, who'd recently been over to her place using the Internet when her own satellite Internet connection was down [9]. She'd recently lost a gig, but under circumstances that differed somewhat from Jett's. When her client didn't call or email to confirm the appointment, she missed their planned meeting which required her to drive an hour and a half to a vineyard. As it turned out, network failures delayed the confirmation message from her client. Sympathizing with her friend, Melissa reflected on a mismatch between expectations of urban customers and rural infrastructural realities, "People who come from the city, they expect to be able to reach us at every minute. And when they don't, they get quite upset about it and sometimes even very angry. They don't really like it if we're too laid back. It doesn't please them at all." In network centers, such delays in response could, she suggests, be interpreted as failures of professionalism, in other words as personal or moral failures, not justified by material or infrastructural factors. Melissa herself elides the apparent material failure of a network delay with personal attitudes seeming to equate the photographer's experience with the accusation of being "too laid back."

There is a general pattern of attribution evident in these stories, one consistent with Western popular perceptions of technological inevitability that locates a failure to adopt or adapt to technology related to certain properties of the individual, presuming every individual is equally able to adopt. In Roger's definition of "laggards" in his theory of technology diffusion, adoption patterns are related to personality types. Those who delay the longest are characterized as more "traditional" (Rogers, 1995). Yet this explanation omits the many constraints that arise from socio-material circumstances rather than personal attitudes.

Maintaining connectivity from a rural periphery

Changes to the Internet itself, including rising data demands and expectations of always on and everywhere connectivity, have exacerbated disparities between the well and poorly connected. In this section I highlight various strategies rural residents used to accomplish and sustain continuous connectivity. They did so by stubbornly persisting with legacy services elsewhere deemed obsolete, by creating redundancy that was

lacking in area infrastructure, by incorporating found materials in the environment into network infrastructure, and by scavenging for bandwidth and data. Occasionally rural residents went further, developing technical expertise and at the furthest extreme even launching their own ISPs [10]. These practices resonate with a history of infrastructural self-provisioning in rural regions of the U.S. that produced first rural telephone and then electricity co-ops (Kline, 2000) and later cable television services (Crawford, 2013).

Persisting with legacy services

The physical infrastructure of the Internet was not only something residents developed an attunement to, it was also something they directly or indirectly configured. One way rural residents in Mendocino County managed their tenuous grip on connectivity was by continuing to subscribe to services that were no longer advertised and only marginally supported by providers. This is another reflection of how rural residents in the periphery struggle with the impositions of network centers. To give one example, Anthony, a writer who'd lived in the area with his family for over two decades, had ISDN service from AT&T which he maintained up until 2014. When he last called about his ISDN connection, he was met with indifference, "I could not convince anybody [in customer service] to look for somebody who knew anything about ISDN to help us and acknowledge that we were even their customer ... they knew nothing about it." His provider continued to take payments for this service so long as there were no support requests from customers. However, gradually this support was silently stripped away.

There are a fair number of dial-up Internet subscribers in the area too. Some are served by a local network provider, Mendocino Community Network (MCN), an ISP with a strongly loyal customer base. MCN provides DSL service and still manages around 250 dial-up accounts. Several residents noted in interviews that MCN was launched with a grant the school district received two decades ago from NASA, a detail perhaps offered to challenge assumptions about the community's marginality. While the cost was extremely low (at only US$19/month) the speed was insufficient for the Internet of today. As one resident joked during a local radio program about rural Internet connectivity, "I can drive down to the bank to do my banking in Mendocino, come home and my online bank still hasn't come up on my screen." The viability of this type of connection was rapidly succumbing to the rising data burden of even ordinary static Web pages.

A number of people in the area also paid significant monthly sums for T1 lines that offered 1.5 mbps throughput speed, well below what the FCC defines as broadband (by both the new 25/4 mbps and old 3/1 mbps standards). The cost was around US$500/month. This price seemed to have been unchanged since the late 1990s, a time period when a T1 line was considered a high-speed service intended for businesses. With these not-quite-obsolete connectivity services came a kind of pricing stasis. While data and bandwidth costs had plummeted in network centers and as the data demands of Web pages, software, and streaming grew, these T1 lines remained at 1998 standards. The T1 connections were dedicated (thus not subject to congestion from shared use among subscribers) and they ran on wired infrastructure (and so were debatably more reliable than wireless alternatives). A local librarian spoke of their T1 line now used for the online catalog. She felt that the benefit was twofold, "for privacy. It's its own entity and it's always nice and slow and steady." It was a redundant supplement to other forms of connectivity at the library including a free, high-speed connection from a local fixed wireless ISP. The stability of T1 connections, however, was enough to maintain a rural customer base.

Creating redundancy

For many residents, reliability was especially critical. This was certainly the case for those who were self-employed doing work for a distant customer base (such as accounting, document translation, software or Web design), time-bound and deadline driven work (like running a local newspaper), or those running businesses catering to tourists. Residents who had the economic resources to do so, would sometimes keep a second network connection as backup. This was typically a different type of service from a different service provider.

The case of Esplanade, the ISP described earlier, explains the necessity of such an expenditure and was the example given by several residents. Further Reach, a new ISP operating in the area, which like Esplanade was a fixed wireless network, filled some of the void left behind by that company's collapse. However, past experience created doubt and hesitancy among some new subscribers. Kevin once a local shopkeeper who'd moved out of the area but remained involved in local broadband issues noted, "my big paranoia about Further Reach is that they're going to go away just like Esplanade did and then CVC [11] did ... we really can't have that. Particularly, for the library and the schools, we've just got to keep the coverage on the coast. I'm totally petrified of losing Further Reach again. Once again, we go dark for three to six months." Married writers, Gerald and Ruby, while mostly thrilled with the service, still maintained a US$70/month satellite Internet connection in addition to the US$70/month Further Reach account. 'We were just about to cancel the service,' they mentioned, until a brief network outage undermined their resolve. A real estate agent in the area noted that he'd kept his T1 line even though he was now connected to Further Reach. He resolved to wait for quite some time to see if this ISP would be different from previous ones.

In well-provisioned network centers, redundancy is largely entrusted to service providers and (where necessary) bolstered by regulations. In rural network peripheries where providers fail to build this redundancy into the shared public infrastructure, residents may create redundancy themselves at the household level. A similar logic is seen elsewhere in the world, particularly in under-resourced economies of the Global South. The walled compounds of the affluent in places like Nigeria house water tanks and electricity generators, barbed wire and private security guards, all signs of mistrust in municipal services such as grid electricity, water, and the police (Larkin, 2008).

A second strategy for creating redundancy put the onus back on companies and government agencies. The Broadband Alliance of Mendocino County (BAMC) pursued consumer advocacy work to document harm incurred during network outages and to bring the redundancy issue to the attention of regulatory agencies. A campaign to put pressure on providers (working through the California Public Utility Commission, which is tasked with serving the public interest) was undertaken to improve reliability for all users in the region. This campaign had realized some measure of success. A hearing was held on 15 July 2016 attended by CPUC commissioner Catherine Sandoval. Subsequently AT&T developed and presented their "north coast network resiliency plan" which was presented to the county commissioners in November of 2016 by Mark Blakeman, VP of External Affairs for AT&T.

A third way of ensuring redundancy of communication was through grassroots self-organizing. For example, a local ham radio group organized to reinforce communications infrastructure broadly. Rachel and Eli, a married couple who were teleworking in the final years leading up to their planned retirement, described the zeal of a local self-appointed community leader who was, "bound and determined to have a minimum of a hundred ham radio operators between Timber Cove and Albion" and who managed, remarkably, to accomplish this goal within a year. Rachel described what drove her participation in the group: "We understand that if there's a catastrophe that no one is going to care that we're here. Nobody is going to send assistance or help. That we're really on our own." The group expected to be the final remaining line of contact in the case of a catastrophe, "the telephone land line won't work. Cell phones won't work. The Internet won't work so the only thing that will work is a ham radio."

In sum, strategies of redundancy took on the form of both individual actions and collective efforts, drew on values of self-reliance or conversely sought to pressure responsible parties and enroll regulatory agencies to improve public-serving infrastructure. They highlight the demand for reliability that follows from the creeping reliance on an Internet connection in everyday work and life. For some, the fundamental issue and motivation for making redundant arose from shared fears about isolation, vulnerability, and urban abandonment.

Resource sharing, repurposing, and scavenging

Borrowing connectivity was critical to a hyperlocal Facebook-based news feed called 'Coastal Sports World' [12]. The feed was especially dedicated to covering high school sports teams and athletes, but also any other news which the site manager Tom deemed interesting. By publishing on this platform, Tom felt liberated from the page limits and printing costs of a conventional paper newspaper. Yet, maintaining a continual news feed, updating (a remarkable 70 or more times a day), required both substantial quantities of data and a consistent and fast connection. For Tom, this had long been difficult to secure.

Tom's contribution to the community, which he did on a volunteer basis, was rewarded with WiFi network passwords at area schools. A supporter paid for his home satellite Internet connection, though it was very poor quality with speeds frequently measuring less than one mbps. Others in the community, he found, were not so generous. He asked for and was denied the wifi password at a local inn and restaurant. They argued the wifi was for, "only our guests who stay overnight." He warned them, "I'm finding out the password and I'm going to put it on the net." This attempt to gain access without permission suggests a kind of true 'scavenging,' that of siphoning from an overprovisioned resource by someone for whom the resource is scarce. He took a dig at the quality of service while admonishing the local inn about their stinginess, "come on, don't be so cheap ... I'm waiting for an hour for a hamburger" he groused. Tom's comment is also a reflection of the kind of social accounting that takes place in a small community where many things are largely self-provisioned. Those who do contribute are noted and remembered and this practice of reciprocity is a key form of social insurance. Tom suggested that the restaurateurs might be unfamiliar with these norms asserting they were, "new in town too ... but they'll become acquainted."

Fixed wireless networks, a type of ISP often found in rural areas, may make heavy use of repurposed or even scavenged resources. Such networks (also referred to as wireless Internet Service Providers or WISPs) are often started by do-it-yourself network engineers who find ways to provision Internet access for themselves in areas at the edge of service (Hasan, et al., 2015; Jungnickel, 2014; Pötsch, 2016). In rural areas, many WISPs are started by a technically adept resident who installs an antenna to extend service to a nearby neighbor and then expands beyond that in an ad hoc manner. Some WISPs begin as formal businesses and may grow to serve thousands of subscribers. In order to serve widely dispersed customers in rural areas, often on remote farms or properties, WISPs must carefully minimize costs. Fixed wireless networks are based on the same kind of wireless used in home networks. They save costs by using unlicensed spectrum [13]. By using highly directional antennas WISPs are able to send data over much greater distances than the radius typical of an in-home wireless access point. In the past, the required hardware to do this was self-customized, but it is now available off-the-shelf from companies such as Ubiquiti and Cambium Networks. In this way, home wifi has been cleverly repurposed to serve customers over a spread of many miles.

Spending several days touring Further Reach, a new fixed wireless ISP in Mendocino County, I came to understand that the success of a WISP can depend on finding ways, often highly opportunistic, to develop and extend the network's physical topology. At times this meant sensitive people work to secure agreements with landowners. WISP operators often rely on local intermediaries who know what strategies to employ to approach particular individuals. Generally, to maximize network coverage, WISP operators seek out tall hills that can serve as natural towers or find existing structures upon which to mount antennas. The CEO of Further Reach, for example, while dirt biking off road, discovered an abandoned PG&E tower that became a relay site after a round of negotiations with the landowners. In this way, abandoned infrastructural elements could be taken over and given new purpose and value.

These various forms of scavenging are examples of infrastructural path dependency whereby older infrastructures and utilities become material platforms for new ones (Parks and Starosielski, 2015). For example, fiber optic cables typically follow the existing infrastructure of roads or railways. Cost is one reason new infrastructures are often built upon or alongside old ones. Cable-laying trucks are used most efficiently when set to follow an already cleared and continuous path (Starosielski, 2015). The practice of scavenging involved both siphoning from an over-provisioned resource (as in the case of 'Coastal Sports World' news feed) as well as revitalizing abandoned and forgotten structures, such as towers.

Conclusion

By examining the inadequacies and struggles over connectivity faced in a rural community and the ways residents strategize to improve their Internet connections, my intent was to highlight some limitations in popular approaches to understanding digital inequality. In particular, approaches that measure inequality by population demographics and frame disparities as a 'digital divide,' rely on a limited understanding of patterns of technology innovation and uptake. A standard account of technology diffusion presumes that as the uptake and use of a technology rises, problems of non-access are solved linearly. Technology non-use is still frequently attributed to the characteristics (or even character) of non-users themselves [14].

The Internet has undergone a metamorphosis in the past decades. It is experienced very differently depending upon one's location in the network. Some are located at network centers, where service approaches the ideal of always on and unlimited, while at network peripheries service falls far short of this ideal (Gregg, 2010). Within this network dynamic rural users are sometimes subject to the impositions and expectations of those at urban network centers. For those who still lack an Internet connection, as the Internet becomes increasingly entwined with the processes of everyday institutions, non-use becomes ever more burdensome. There are also social expectations: that one has an e-mail address (and checks it regularly) or can receive a multi-megabyte file attachment. These expectations, particularly about the speed and reliability of the network, have also gradually become built into the Internet itself, in default configurations that consume data invisibly in the background, auto-play features, and services that have no 'offline' use mode.

The experiences of rural Internet users highlight concerns over the quality of the Internet connection that go beyond the way it is most commonly measured, in terms of its throughput speed (aka bandwidth). Reliability is often a more critical concern. This is more than a matter of periodic downtime. Small ISPs may be here today and then gone altogether tomorrow. In the present, rural residents manage by siphoning from surplus data and bandwidth capacity, creating their own systems of redundancy, or (in some cases) launching a community-based, local ISP when large incumbent providers fail to show an interest in the area. These strategies continue a long tradition of rural technological and utility service adaptation and self-provisioning.

About the author

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Notes

1. The original formulation of a digital "divide" among policy-makers is usually attributed to an NTIA report titled "falling through the net" (Brown, et al.,1995).

2. In "Birth and demise of a dream," published 11 April 2011 in the Independent Coast Observer Esplanade co-owner Teri Saya explains the sudden shutdown of the ISP.

3. There is no copper or other valuable metals in a fiber optic line.

4. Espinoza and Anderson (3 September 2015) "Vandalism blamed for massive phone, Internet outage on North Coast," Press Democrat, at http://www.pressdemocrat.com/news/4429875-181/internet-phone-and-wireless-service?artslide=0.; "September 2015 telecommunciation outage and the impacts on residents in Mendocino County," at http://www.mendocinobroadband.org/wp-content/uploads/Outage-Report-as-approved-

11216-by-BoS.pdf; Burns (9 October 2015) "Beyond redundancy: Why last month's AT&T outage sucked so bad," Lost Cost Outpost, at https://lostcoastoutpost.com/2015/oct/9/t-outage/.

5. AT&T's lobbyists are working to get state legislatures to pass bills including in California. The most recent relevant bill, AB 2395, failed to pass in 2016.

6. The data for this figure was compiled from several sources. Data points for 1995 and 2003 come from Domènech, et al., 2007. Data points for 2009 to 2017 come from HTTP archive measurements — https://httparchive.org/reports/state-of-the-web. Download times were calculated using the tool at http://www.meridianoutpost.com/resources/etools/calculators/calculator-file-download-time.php and calculating 50 percent overhead for Internet protocol handshaking delays. To download a single Web page involves dozens of individual requests for each element on the page thus requiring this overhead calculation.

7. Connectivity struggles are also exacerbated for particular demographic groups.

8. All names are pseudonyms excluding citations from the public record.

9.Satellite Internet service availability is subject to weather conditions and, in particular, dense fog (a frequent occurrence in coastal regions) can affect signal strength.

10. ISPs with origins in the community were typically fixed wireless networks, generally the only feasible form with a low enough financial barrier to entry.

11. Another fixed wireless network operating for a short time until a property owner decided not to renew a land leasing agreement they had for hosting some towers for the ISP.

12. A pseudonym.

13. By contrast, national licenses for wireless spectrum are auctioned off by the FCC to large national carriers like AT&T and Verizon often for sums in the hundreds of millions of dollars.

14. On the continuing assertion that non-use is a problem of user disinterest see Levin and Downes (14 October 2016) 'A new digital divide has emerged — and conventional solutions won't bridge the gap' Washington Post, at https://www.washingtonpost.com/news/innovations/wp/2016/10/14/a-new-digital-divide-has-emerged-and-conventional-solutions-wont-bridge-the-gap/.

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