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Disability, Connected Cars, and Communication

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In this article, I take up a highly visible theme in discourses, experimentation, and manufacture of connected cars and autonomous vehicles: disability. I analyze the leading ways in which this new kind of technology is imagined for particular users with disability, as in the highly publicized case of Google's pilot driverless vehicle promoted as a boon for blind people and those with vision impairments. Then, I try to stand this kind of framing of connected-cars-as-good-for-disability on its head, and discuss the implications for questions of emerging social technology, equality, diversity, and design. Reflecting on this analysis, I look at what disability tells us about connected cars, and, indeed, how we might rethink communication and technology.

Keywords: disability, connected cars, autonomous vehicles, communication, mobile communication, accessibility, diversity, design

Since the 2000s or earlier, new dimensions of communication have emerged in response to developments in cars and technologies, such changes in their turn being tightly associated with convergence of communication with mobile technologies, transport infrastructures, and mobilities.

Consider, for instance, the incorporation of mobile communication and media technologies and cultures into cars and car cultures, and vice versa, and the social implications these transitions have entailed (Arceneaux, 2012; Bijsterveld, 2010; Ling, 2012). Users of mobile phones have long had a vexed relationship with cars (Jessop, 2006), not least via the extensive social anxieties and sustained attempts to discourage, regulate, and fashion appropriate norms of using mobile devices in vehicles. As part of this process, mobile phones have been integrated into the audio systems of cars, providing a way, via Bluetooth and amplification, for drivers and passengers to talk on their phones, hands-free. With the advent of smartphones, and their widespread, taken-for-granted use for entertainment, news, information, navigation, and many other functions, such mobile devices and social media platforms increasingly have been designed for integrated use in cars (at roughly the same time as car manufacturers designed on-board information and entertainment systems with apps; Goggin, 2012; Juhlin, 2013). The second recent key development in cars, mobile technologies, and mobilities is related to and has to do with the cluster of

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technologies associated with "driverless" or connected cars, assisted driving, and autonomous vehicles (W. J. Mitchell, Borroni-Bird, & Burns, 2010). Here, we see a distinct new stage of the relationships among communication, technologies, and their users and nonusers (Shepherd, St. John, & Striphas, 2006). In this article, I seek to shed light on the emergent forms of communication in this moment of connected cars via a critical account of disability and mobility.

Figure 1. "Look, Ma, no hands": Steve Mahan, Google self-driving car test (Google, 2012).

Why disability? Well, to start, we might notice that disability has been a leitmotif of the discourse of connected cars. Consider, for instance, Google's self-driving car project. In 2012, Google publicized its initiative via a widely watched video of Steve Mahan from the Santa Clara Blind Center, taking his first test ride in the driver's seat (accompanied by another test driver; see Figure 1). In the official story from Waymo (Google's spin-off self-driving car company, created in 2016), Mahan features in the section of narrative when the project moved from its inception in 2009 to the period in 2012 when it "moved to complex city streets" (Waymo, n.d.). People with disabilities figure as handy, resonant examples for Google and then Waymo to underscore its goal: "We're working towards fully self-driving cars that make it safe and easy for everyone to get around" (Waymo, n.d., para. 1).

Analyzing such instances in how connected cars are imagined and presented, in this article, I argue that the visible presence of disability in the emerging field of connected cars offers important insights into the nature of communication and technology. As such, this article is a response to a conjuncture in which disability is an emergent topic in communication and media studies. As well as important work developing around longstanding preoccupations such as cultural representation, there is a rich new area of work on communication and technology influenced by disability studies. This work provides points of departure, conceptual resources, and new critical angles for understanding the sociotechnical formations, social relations, and possibilities of emergent technologies such as connected cars.

Technology is an important area for people with disabilities because of the increasingly vital role that technology plays in everyday life. This is the case for nearly everyone; however, there are particularly productive relations between disability and technology to be observed, ranging from the essential support technology can play in the beginning and end of life, in keeping people with disabilities alive, and in providing tools and support for quality of life and social participation. Digital technologies, cultures, and social practices, especially, have provided new communicative architectures, repertoires, and options for people with disabilities, as highlighted across a wide range of contexts and cultures of use, from Web accessibility to captioning and audio description of television, through new forms of access supported by mobile phones and tablet computers, to modes of haptic media (Blanck, 2014).

A prime contention arising from new work in disability communication and media research is that disability prompts us to rethink the nature of communication (Alper, 2017; Alper, Ellcessor, Ellis, & Goggin, 2015; Ellcessor, 2016; Ellcessor & Kirkpatrick, 2017), especially when it comes to technology (Blume, 2012; Ellis & Goggin, 2015, 2016; Ellis & Kent, 2011; Forlano, 2016; Gallis, 2011; Goggin & Newell, 2003; Mills, 2018; Mills & Sterne, 2017; Roulstone, 2016; Seelman, 2001). Here, disability intersects with other efforts to draw attention to the rich dimensions of communication often overlooked, such as the full extension of senses, the implications of technology for reconfiguring communication, the environments of communication, nonhumans and communication, and machines and communication (Gillespie, Boczkowski, & Foot, 2014; Katz, 2003; O'Riordan, 2017; Peters, 1999, 2015; Sandry, 2015; Suchman, 1987).

Against this backdrop, the article proceeds as follows. First, I discuss the relationships among disability and cars, and then develop the analysis to indicate the contours of a deep theoretical framework on communication that helps make sense of their relationships. Second, I discuss leading examples of how disability has emerged and has been featured in connected cars' development, design, policy, and discourses. Third, I draw together these analyses with suggestions on the insights disability has for how we might think about the present conjuncture of communication, transportation, and media.

Cars and Disability

There is an oft-cited, still telling observation from disability scholar Michael Bérube:

> The cultural representation of people with disabilities affects our understanding of what it means to be human; in more practical terms, it affects public policy, the allocation of social resources, and the meaning of civil rights. (Bérube, 1997, pp. B4–B5; cf. discussion in Jaeger & Bowman, 2005, p. 95 ff.)

To this list, we can add "communication," of which an excellent example can be found in the case of disability and cars.

To start, cars are often prominently represented as cause of disability, typically through car accidents that result in catastrophic, enduring, and life-altering impairment. Clearly, car accidents are a leading cause of significant impairment. A 2015 World Health Organization (WHO) report estimated that some 50 million people worldwide suffer major injuries from road traffic accidents. The approximate

percentage of crash victims with permanent disability varies widely across countries (because of issues in data collection), but, as the WHO report notes, is often suggested to be in the range of 10–20%. It is not surprising that driver safety education, policy initiatives, media coverage, and everyday discourses all feature images and narratives of the profound consequences of car accidents, dramatizing the ways in which such shock occurrences leave drivers, passengers, pedestrians, and by-drivers seriously impaired.

While car accidents clearly are a leading cause of impairment and disability, it is notable that the way that disability figures in such cultural representations often fits the classic stereotype as disability-as-tragedy (something encapsulated in the profoundly entrenched idea of "better-off-dead-than-disabled"; Ellis & Goggin, 2015; Haller, 2010). These kinds of tropes still often feature at the heart of shocking and highly emotive advertising, marketing, and public health and safety campaigns. To give just one example to indicate the deep embeddedness of this dominant cultural representation, consider advertising for Paralympic sports, which in recent years have become one of the most common ways that audiences internationally encounter disability in media and society. The narrative of the celebrated advertisement for the 2012 London Paralympics, entitled "Meet the Superhumans" (Tagholm, 2012), revolves around an athlete whose acquired impairment via a car accident is dramatically depicted (see Figure 2).

Figure 2. Athlete in wheelchair juxtaposed with car wreck (Source: Tagholm, 2012).

This widely watched and shared advertisement has various innovative, "edgy," and nonstereotypical representations of disability; however, the framing of disability as "acquired" and involving a life-changing tragic event remains central to the narrative. In summary of this brief discussion, we can see that car accidents loom large in health and disability statistics, experience, and cultural representations. Via advertisements, especially, such as that of the Paralympics, as well as many road accident prevention and safety campaigns, we can observe the dominant framing of cars and disability.

This second leading way in which disability is represented in relation to cars revolves around the idea that progressive impairment can result in individuals being unable to drive safely and eventually to be obliged to stop driving. The waning and foreclosure of driver careers are associated with concomitant and significant loss of mobility and independence, as well as altered self- and social identity. Regarding cessation and other transformations in driver agency, there is a significant discourse as well as body of research, the bulk of which is focused on aging rather than disability. (Of course, aging and disability have significant crossovers and areas in common [Bigby, 2004; Jeppsson-Grassman, 2013]; however, it is important to distinguish analytically, socially, and politically between aging and disability before then tracing their intersectionalities [e.g., Cilio & Lustig, 2018].) We can find some work that explicitly addresses disability, as we can see in literatures on driving by people who have experienced strokes, acquired brain injury, dementia, or other degenerative or episodic conditions (e.g., Liang, Gustafsson, Liddle, & Fleming, 2017; Yu et al., 2016). However, both the predominant work and most prominent conversations have focused on aging and older people. Key topics include justified concerns arising about how the processes of aging, health, well-being, cognitive, and other changes affect ability and perceptions of the extent to which older people meet the norms and requirements of driving. Some other research also delves into the consequences of "retirement from driving," a major issue for aging when automobiles in many societies are an essential service (McCarthy, 2005, pp. 247–248).

For some time, emergent technology has been viewed with interest for its promising scope to provide new ways to address this societal challenge and provide vital support to drivers as they age, as it is hoped that technology can assist people with other aspects of aging (Boot & Scialfa, 2016; Bouma & Graafmans, 1992; Chau & Osborne, 2017; Cotten, Yost, Berkowsky, Winstead, & Anderson, 2017; Helai, Mokhtari, & Abdulrazak, 2008; Hyde & Higgs, 2016; Reimer, 2014).

Interestingly, there are few studies that adopt a critical lens on how aging is represented in such expanding discourse and research. Whereas there is a significant and growing literature on aging, generations, and media (Bolin, 2017; Fernández-Ardèvol & Prieto, 2012; Fernández-Ardèvol, Sawchuk, & Grenier, 2017; Fortunati, Taipale, & de Luca, 2017; Lee, 2014; Nixon, Rawal, & Funk, 2016; Sawchuk & Crow, 2014), there is almost no work that brings to the surface the deep disableist assumptions in such conversations on aging and driving. Yet, on the face of it, we can hypothesize a strong connection among three things: illness, health, and aging; discourses and negative perceptions of illness, health, and aging being a deficit or barrier for driving; discourses that valorize driving as strongly correlated with and resonant of mobility, autonomy, and freedom. Very likely woven into this complex situation is an accompanying hypothesis that although the social imaginaries of aging and disability are distinct, they are also interwoven (Rodan, Ellis, & Lebeck, 2014; Roulstone, 2016), especially when it comes to social identities and driving. As a preliminary way to make sense of these dynamics and their deep structures, it is useful to briefly reconsider fundamental concepts in communication that bear closely on transportation, technology, and movement and mobilities.

Especially since the pioneering work of Harold Innis (1951/1991) and James Carey (1989), scholars have discussed the relationships between communication and transportation (Sterne, 2006) and the pivotal role that particular systems of communication technology (notably the telegraph) have played in forms, practices, and notions of communication. Various scholars have argued for the significance of the car, and

of automobility, to how communication and media take shape in the late modern era. For my purposes here, I find the work of James Hay and Jeremy Packer (2004) especially helpful, especially their contention that automobility "allows us to focus squarely upon the mobility and 'mobilization' of media . . . the mattering of media and communication technologies within changing regimes of mobility" (p. 213). Hay and Packer see automobility as a Foucauldian "technology of the self" (p. 230), bound up with core questions of power and freedom in contemporary society. I also find useful the work of Eric Laurier and Tim Dant (2011), who from a different angle, in their examination of what people do while driving, also note the nodal meanings and power that cluster together in social life in cars (p. 241).

Reflecting on these two critical accounts of automobility puts an overarching question in sharp relief: What does the moral economy or order of automobility, and its broader social relations (Laurier & Dant, 2011, p. 223), look like for those explicitly excluded from driving and communication? Furthermore, what kinds of governance and power shape the moral, cultural, and political economies of driving and communication for a range of different populations? Returning to disability, cars, and communication, it would seem a plausible hypothesis that the threshold issue is that disability has been largely left outside the social imaginary of driving. At least, this would be the initial picture that emerges from considering the dominant versions of automobility.

One important recent conceptual, research, and political platform for better articulating and addressing these questions flows from the rise of mobilities research over the past 15 or so years. Mobility research has expanded our sense of the varieties and horizons of mobilities, and has raised questions of mobility justice (Sheller, 2011, 2016). Recent mobilities research has also sought to explicitly acknowledge the mobilities of disabilities, and to put disabilities into the mix when it comes to understanding bodies, kinds, infrastructures, and politics of mobilities (Goggin, 2016; Parent, 2016). What such critical resources from disability studies and mobility research point to are the kinds of bodies and identities that underpin the moral economies of cars, communication, and transportation of automobility in the 20th century (Alessandrini, Campagna, Delle Sitte, Filippi, & Persia, 2015; Büscher, Coulton, Efstratiou, Gellersen, & Hemment, 2011; Manderscheid, 2014; Moser, 2006). For their part, as I now explore, critical conceptions of disability and mobility also offer us resources for addressing the new kinds of governance and "sociospatial arrangements" that are emerging with connected cars.

The Coevolution of Connected Cars and Disability

Cars contain particularly useful affordances for providing and extending mobility. However, cars also can be inaccessible for drivers and passengers alike. Thus, cars have been the source of considerable contradiction and frustration for many people with disabilities. Many of the important meanings of cars have been associated with the convenience, traits, and pleasures of being in the driver's seat, so to speak. However, most cars are not designed or imagined for drivers with particular kinds of significant impairments, for instance, people with mobility or dexterity impairments. So, over many years, cars have been modified to allow alternative ways to activate key controls––accelerators, steering wheels, and so on. Cars have also been modified to allow for easy stowage of wheelchairs. A wider body of design and modification is evident when it comes to passengers, especially in cars used for public and commercial transportation, such as taxis. Here, we see many instances of accessibility taxis, including modified, lengthened, extended, or redesigned

cars, that will carry someone in a power wheelchair or motorized scooter, offer handles and other supports for easy for ingress and alighting, and so on. As cars have become much more reliant on ICTs for driving, navigation, and controls, as well as becoming more intensely and richly configured for on-board media consumption and ICT use, questions have been raised about the need for accessible instrumentation, controls, and entertainment and media systems (Ferati, Murano, & Giannoumis, 2017).

For the most part, this tradition of accessible design of and for cars has remained relegated to being a minority endeavor. As we have seen already, in the context of aging, accidents, and episodic, degenerative, cognitive, and dynamic conditions, there is a well-established exclusion of many people with disabilities from the driver's role. If we explore this exclusion further via more commonly recognized disabilities, we find a fascinating set of dynamics at play. One of the most celebrated cases here is that of blind people and those with vision impairments and associated conditions. There are deep meanings associated with driving automobiles, and a deep sense of loss (akin to melancholia), when one loses the ability to drive (or cannot drive). This is evocatively put by the U.S. blind advocacy leader and, as we shall shortly note, National Federation of the Blind (NFB) President Mark Riccobono:

> The allure of the car and the perceived opportunities that come with driving are so strong that, when one loses the ability to drive—from blindness or some other cause—it is frequently thought to be among the worst losses one must overcome. (Riccobono, 2009, para. 4)

As noted by various commentators, there is an obvious irony here, evident when we review the history of automation in cars. One of the celebrated pioneers in car automation systems, the inventor of the "Speedostat," and then "auto pilot and cruise control," was a blind man, Ralph Teetor. Teetor lost his sight after an accident when he was five years old; yet, he completed school, and in 1912, graduated in engineering from the University of Pennsylvania. Teetor succeeded his father as the chief executive officer of the family's Perfect Circle automotive parts company (Anderson, 2008). Eventually, he received accolades and awards for his design, engineering, and invention work in the automotive industry (Meyer, 1995). Teetor's invention of cruise control is attributed to the frustration and discomfort he experienced as a passenger when drivers were unable to maintain a steady speed (Meyer, 1995). Teetor's role in automobile innovation is often noted as a fascinating sidebar in accounts of contemporary driverless cars. However, it could be read as a site of disability innovation in automobility, an instance of something that Aimi Hamraie and Kelly Fritsch have called "crip technoscience" (Hamraie & Fritsch, 2017; see also Fritsch et al., 2017; Hamraie, 2015, 2017).

Despite such entwined histories of blindness, disability innovation, and cars, the idea of blind driving has been often regarded as anathema until recently. Often we see the blind driver appear as a literary conceit, as in the 1989 novel *The Widows' Adventures* (Dickinson, 1989). Often this amounts to the common, deeply ableist literary device famously theorized by David Mitchell and Sharon Snyder (2000) as "narrative prosthesis." Even user-centered and inclusive design proponents have referred to "situations where 'design for all' is certainly not appropriate (e.g., blind drivers of motor cars)" (Newell, 2008, p. 790). Ironically, we find that such deeply culturally embedded assumptions about disability persist at the very

time that the apparently unthinkable idea of the blind driver as an entrenched concept in automobility culture is being fundamentally challenged.

An early initiative in this regard occurred in 2004 when the Jernigan Institute of the U.S. NFB launched its Blind Driver Challenge:

> In 2000 President Maurer asked us to dream about what we might do as together we built the Jernigan Institute, the nation's first and only research center run for and by the blind. He suggested two possibilities. One would be a handheld reading machine portable enough to let us read print wherever we might go and wherever we might find it. The second was a car that a blind person could drive. (Wunder, 2011, para. 2)

Virginia Tech was the only university to initially accept the challenge, doing so in 2006, with its undergraduate students receiving favorable publicity for blind drivers doing a test drive (see Figure 3; Mack, 2009). The vehicle used voice software to tell "the driver how far to turn the wheel" (Mack, 2009, para. 5), indicating the turns by clicks. Then it also used primitive haptics to signal speed: "A vibrating vest provides cues to follow when accelerating and decelerating" (Mack, 2009, para. 6).

Figure 3. "Students build a car the blind can drive."
Source:* Wired *magazine (Mack, 2009).

A key figure in the Virginia Tech initiative was Dennis Hong, well known for his widely watched 2011 TED Talk (see https://www.youtube.com/watch?v=O2OQxHNVLNY; Hong, 2011). Hong recounts that for their Blind Driver Challenge, rather than simply designing a car that drove a blind person around, the NFB stipulated a car in which "a blind person could make active decisions and drive, so we had to throw everything out the window and start from scratch" (Hong, 2011, 1 min 20 s). So, Hong's team built the 2009 prototype described above, driven around a controlled environment by a test group of young blind

people (Mack, 2009). From the prototype, Hong's team embarked on a more ambitious design, designed around perception, computation, and nonvisual interfaces (Hong, 2011). Launched with great fanfare in a sporting stadium, driven by NFB President Riccobono, the resulting experiment was acclaimed a historic first (see Figure 5; NFB, 2016).

> Driving a car is a powerful symbol, and in the end it matters very little whether we are licensed to drive generation twelve of the blind driver vehicle, Google 26.2, or something none of us can yet envision. . . . Might this event have begun the process of changing our language so that the term "blind driver" might one day move from insult to statement of fact? (Wunder, 2011, para. 22)

Figure 4. Mark Riccobono, the first blind driver, at Daytona International Speedway, January 29, 2011 (NFB, 2016).

The story of Dennis Hong and his work designing cars for blind drivers is one early, illustrative case in a research and technology development field that has expanded. Since then, for its part, NFB has continued its leading role in encouraging and codeveloping cars with nonvisual interfaces suitable for blind drivers. However, such efforts and publicity of pioneering efforts by scientists and disability organizations alike have been become overshadowed by the mainstream take-up of the dream of the blind driver––as a constitutive element of the social imaginary of the connected cars. The case in point is Google, for whom blind drivers become a leitmotif, at the threshold moment of publicizing and building support for its driverless car project.

Google, Waymo, and Connected Car Dreaming

As noted earlier, Google's "historic first" test drive of a self-driving car in 2012 featured Steve Mahan, then chief executive officer of the Santa Clara Valley Blind Center: "When Google chose to publicly introduce its self-driving car to the world, it chose to highlight the impact that it would have on Steve Mahan's life through a video the company posted on YouTube" (Claypool, Bin-Nun, & Gerlach, 2017, p. 20). This is not the only time that Google has portrayed blind consumers as emblematic of its technology innovation. Another well-publicized instance by the company was its now-abandoned Google Glass experimentation product, which Google promoted as having potential benefits for consumers with disabilities. Google sought users and organizations, including disability organizations and tech companies serving them as customers, to partner with and encourage the necessary innovation and implementation (Ellis & Goggin, 2016). In 2015, Google launched its Impact Challenge: Disabilities (see Figure 6), awarded USD$20 million to 29 projects addressing accessibility challenges ("Meet the Innovators," n.d.), explaining, "We're supporting forward-thinking nonprofits with big ideas that use technology to expand opportunity and independence for people with disabilities" ("Working Together," n.d.).

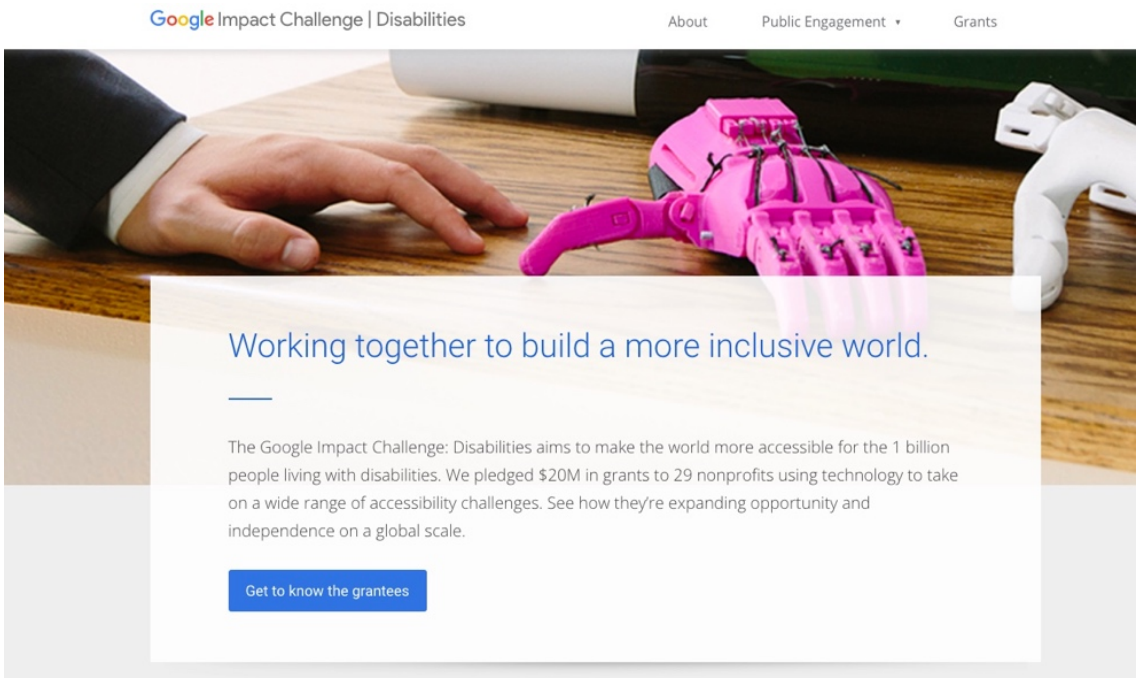

Figure 5. "Working together to build a more inclusive world"— Google Impact Challenge (Source: "Working Together," n.d.).

Google's focus on and development of disability and accessibility-related aspects of emerging technology are encouraging. A signature strategy is collaboration, working with disability and assistive technology communities and practitioners, evident in the Google Glass experiment. However, it is not clear that Google follows up and puts accessibility requirements and disability design at the heart of its innovation, business, product, and implementation processes. The Impact Challenge, for instance, is a worthy initiative, yet it is reminiscent of many other corporate sponsorship and corporate citizenship programs, not least as it is funded from Google's "charitable arm," Google. org (Vincent, 2016).

Figure 6. "There are one billion people with disabilities in the world"—Google's Impact Challenge: Disabilities (Source: Google, 2015).

The seriousness of its commitment to disability and accessibility in its own products and policies is clearly at the forefront of Google's considerations, as it is squarely addressed in the blog post announcement of the disabilities Impact Challenge (see Figure 7; Google, 2015). Google has continued this "team effort" approach in subsequent initiatives, for instance, in its call, issued by one of its software engineers, Sasha Blair-Goldensohn, a person with disability, to improve information on accessibility in Google maps (Blair-Goldensohn, 2017; Heasley, 2017). In other ways also, Google's acknowledgment and engagement with aspects of disability culture as part of its broad imagining of its role in digital and general culture can be innovative and thoughtful. A good example of this is Google Doodle (the daily featured image on Google's search page), carrying an artwork depicting pioneering U.S. disability rights leader Ed Roberts giving a lecture ("Ed Roberts'," n.d.).

In such a survey and assessment, a picture emerges of a technology corporation that has often drawn attention to key disability and accessibility issues in pioneering ways. Yet, it is unclear how Google addresses these concerns consistently and systematically over the long term. There are signs of a patchy,

underresourced, minor engagement with disability in the case of Google's efforts on driverless cars. After its initial developmental and promotional work on driverless cars, showcasing people with disabilities as a historically neglected group of the population who might be beneficiaries, discussed above, parent company Alphabet has switched its focus. As noted, via its spin-off driving technology company, Waymo now pitches an inclusive vision reminiscent of universal design philosophy: "safe and easy for anyone to get around " ("On the Road," para 4, n.d.)Waymo's official positioning seeks to incorporate its work on disability as part of a larger effort to expand accessible transport ("On the Road," n.d.). This kind of position––both listening to and collaborating with particular groups and individuals, such as disability communities, as well as parlaying this knowledge and building on these relationship––to improve transportation could potentially work well. Indeed, it could thread into the new wave of serious investment and ventures in driverless cars, which Waymo is knitting together.

Notably, on February 22, 2018, Waymo announced that it had been given state government approval to launch an autonomous self-driving taxi service in Phoenix, Arizona (Collins, 2018), setting the scene to scale up its joint venture with Chrysler and extend its trials. This announcement followed hot on the heels of a legal settlement of the case in the U.S. Federal District Court between Waymo and Uber, the ride-hailing company, nearly one year after Waymo accused its rival of plotting to steal its laser-sensor technology, a key component in driverless cars (Wakabayashi, 2018). In the settlement, Uber agreed to provide Waymo with 0.34% of its stock, adding to parent company Alphabet's considerable investment in Uber (Wakabayashi, 2018). Alphabet is also a significant investor in Lyft, one of Uber's other major U.S. competitors (Wakabayashi, 2018). These kinds of contest over intellectual property, trade secrets, patents, and other claims to rights over technology innovation are familiar from the histories of many other technologies, not least, in recent times, smartphones. Thus, the larger picture of the business strategies, politics of technology innovation, and the political economy of technology companies (including the new sector of driverless cars) is a key context for understanding the trajectories of disability and communication unfolding here.

Although such support for the kind of collaboration advanced by Google, Waymo, and other Alphabet technology companies is welcome, an explicit critique can also be made of this context and such corporate responses. A commitment to and involvement in expanding accessibility of technology, as in the case of disability, are something that is clearly beneficial for a company's reputation. Such disability innovation initiatives offer potential for "good news" stories, to offset negative perceptions and coverage of other aspects of the same technology, whether data privacy and surveillance (Google computing, Internet, search, mobile, and other products), intrusiveness of pervasive, wearable computers (the perceived "creepiness" of Google Glass), or the mortal and bodily dangers and determination of culpability associated with driverless vehicles (sadly evident in the tragic death in Arizona on March 18, 2018; Wakabayashi, 2018).

Especially in areas of digital, online media, where content, tools, and code development are very much user-generated, distributed, and collective, the overarching problem remains that such codesign, collaborative efforts are on the margins of the central resource and technology systems' dynamics and developments. Add to which there is little consideration of, or support for, the kind of ecosystem and innovation system creation and incentives and policy frameworks to take disability and accessibility

seriously, which are really needed (Kirkham, 2015). These kinds of issues were raised with Google Glass, where disability and accessibility were presented by the company as having much potential, and offering a great opportunity for developers and disabled users and communities to adapt and develop in innovative ways (e.g., Anam, Alam, & Yeasin, 2014; McNaney et al., 2014). This led to very interesting initiatives and partnerships, including bids for crowdfunding to support further accessibility development (Ellis & Goggin, 2015). Conspicuously, however, neither Google nor later the Alphabet group of companies has created or committed to a major, systematic, and properly resourced priority initiative and framework on disability and accessibility.

Reflecting on these emergent characteristics of disability, accessibility, and technology, I would argue that although Google often seeks to engage with and promote disability concerns, this sits alongside (and may well be trumped by) the Alphabet corporation's cleaving to (1) the primacy of the business and political economy forces that subtend the emerging connected car area, as relatively established digital communication, computational, Internet, and media corporations (viz. Alphabet), face off and form alliances with new corporations that are focused on leveraging such digital platforms for reworking transportation, logistics, retail, and hospitality industries; and (2) by-and-large mainstream approaches to the complex communication and mobility issues faced across the emerging connected car field.

Other companies, scientists, tech developers, and disability advocacy, policy, and research groups have also taken up the cause of people with disabilities and driverless cars (see discussion in Bradshaw-Martin & Easton, 2014; Claypool et al., 2017). There has also been a widening push for development of inclusive and universal design in key automobile interfaces (Ferati et al., 2017). Such efforts underscore the reality that the complex, continuing dynamics of accessibility go to the heart of the (digital) exclusion currently faced by drivers and passengers alike, whether controlling and using controls, instrumentation, and features of cars; taking advantage of on-board or connected media, information, and communication technologies; or experimenting with new haptic and other technologies in driving cars (Sucu & Folmer, 2014).

Despite these efforts and attendant publicity, it is not surprising that the first major report on the subject suggested that the "buzz" had not yet translated into widespread discussion, let alone concrete breakthroughs:

> Yet, there is relatively little discussion of the use of autonomous vehicles to serve individuals with disabilities. This is not due to the pace of technological development—which is well underway—but more of a function of the community's ability to organize and articulate a demand for products that are both feasible and impactful. (Claypool et al., 2017, p. 22)

In response, disability advocates, designers, developers, and researchers have sought to intervene across a wide range of fronts in which the shaping of connected cars is occurring (Beene, 2017; Woyke, 2016). The major U.S. lobby group Self-Driving Coalition for Safer Streets includes the NFB, United Spinal Association, and Mobility4All as partners, in addition to its member Ford, Google's Waymo, Lyft, Uber, and Volvo (Self-Driving Coalition for Safer Streets, n.d.-b). The Self-Driving Coalition defines self-driving vehicles

as Society of Automotive Engineers Levels 4 and 5, where "vehicles will be equipped with sensing and computing systems that do not rely on a human to take over in any situation within a defined operation domain" (Self-Driving Coalition for Safer Streets, n.d.-a, para. 6). A direct implication of such definitions is the urgent need for reform of the laws and policy that would enable and regulate self-driving vehicles. In the transition from a situation in which particular kinds of impairment can disqualify individuals from driving to the creation of new frameworks to permit and support a more diverse range of drivers, especially people with disabilities and older people, then new approaches are essential, as well as the removal of attitudinal and other barriers. At stake here are the norms of who is imagined as and permitted to be a driver, and what driver behaviors entail (Bradshaw-Martin & Easton, 2014). Also key are the financial, risk, and legal assumptions and models concerning liability and insurance (Mele, 2013).

While framing these issues as important concerns of accessibility, digital inclusion (Goggin, forthcoming), and policy imperatives, as they surely are, I suggest it is necessary to go much wider and deeper, and to acknowledge and push the exploration of the ways in which disability and cars are linked to, and provide perspectives on, fundamental questions of human–machine, human–technology communication, and communicating with machines as thoroughly discussed and theorized questions across several disciplines and fields of research (e.g., Bollmer, 2016; Papacharissi, 2018; Saariluoma, Cañas, & Leikas, 2016). A full discussion of the implications of thinking about disability and self-driving cars will require dedicated, extensive discussion. As one indication, suffice to say here that new perspectives on disability provoke and require us to rethink our categories of the human, as do entangled and emergent perspectives from other areas such as science and technology studies, environmental humanities, nature–culture studies, and animal studies (Ray & Sibara, 2017). Amid the diversity of the worlds we inhabit with disability is a range of relationships that offers rich resources for how we reimagine and reshape human–technology relations, especially in a conjuncture whether older, unhelpful Manichean notions of humans versus machine are invoked (Roulstone, 2016). In the present case, if we appreciate, explore, and unpack the deep structuring of disability in communication, we can also dismantle the specific roadblocks in reimagining cars and other mobility technologies at the present conjuncture and in plans for the future.

Concluding Remarks: Other Histories and Imaginaries of Wheels, Driving, and Communication

In this article, I have traced and drawn attention to the striking prominence of disability in contemporary developments and discourses of connected cars. My treatment is preliminary only, and focuses on a limited set of examples, notably experimentation and promotion of self-driving cars by one high-profile disability organization in the United States and associated researchers, and then by Google and Waymo. This is an area that deserves systematic research and analysis by communication scholars as part of establishing and undertaking a sorely needed broader program of work on the social, cultural, political, and design dynamics of connected cars internationally, especially in emerging markets and low- and middle-income countries. This kind of effort is especially important given that disability is not at the center of automotive, convergent media, and communicative innovation and design, despite the publicity it is often accorded by key players.

Although disability has emerged from the shadows to feature more prominently in promotional efforts and discourses (for instance, as a "good news" story or benefit of emergent connected cars), the

reality is that the innovation ecologies and the forces shaping these are not delivering the kind of inclusive technologies predicted and hoped for. The framing of social and ethical challenges in connected cars and associated technologies such as data and algorithms (evident in the hot pursuit in public policy debate for "ethical" algorithms) has typically focused on the scenarios of the social sorting or selection about what class of person might be killed or injured by an autonomous vehicle rather than the actually more pressing and consequential questions of social distribution and inequalities of automated technologies and communication (Eubanks, 2017).

What flows from my analysis in this article is a need to extend conceptualization, practices, frameworks, and resources for design interventions into connected cars that address, incorporate, and use disability as a resource (Boys, 2014, 2017; Pullin, 2011). Here, an important and rich starting point is historiographical thinking, notably the acknowledgment of the alternative histories and politics of technology systems of mobility associated with disability, spurred on by disability histories, activism, and emergent work in crip technoscience.

Such an endeavor would reflect on the struggles by disability communities for accessible public transportation that has driven policy change and infrastructure and technology design and modification (Finkelstein, 1994). Transportation has been a highly significant, vital site of disability activism, which has had ripple effects across other areas of struggles for disability democracy, justice, and rights. It has been an especially resonant issue, evoked in the iconic images of U.S. ADAPT disability transport protests in the late 1970s, spurred by Denver protestors seizing an inaccessible bus in 1978 (http://adaptmuseum.net/gallery/; Spees, 2018), that captured international attention and prompted landmark legal and policy change. Key issues internationally have included lack of funding for accessible public transit and transportation systems, especially trains, planes, and buses (a major issue everywhere, including, for instance, the peripheries of the "megacities" in the Global South or in rural and remote locations); persistent lack of inclusive, innovative, and accessible design in public transportation infrastructure, even in quite recent initiatives; lack of accessible taxis and equitable taxi policies; personal injury and motor vehicle insurance coverage for adapted vehicles for individuals with motor impairments; and the recent issue of the inaccessibility of ride-hailing apps such as Uber and Lyft.

Such an undertaking would also incorporate the histories of modification of vehicles for wheelchair users or those with different kinds of dexterity and mobility (Parent, 2016), and more radically still the sociotechnical and cultural histories of wheeling, rolling, and gliding associated with the wheelchair and the scooter, and disability technologies associated with walking such as the cane, the walking stick, prostheses, and emergent forms of automation, sensors, and computation (Roulstone, 2016). The implications of such histories and accounts of embodiment, disability, and technology can be glimpsed in the pushback and critiques from disability communities on some news coverage and public responses to scientist Stephen Hawking's death in March 2018 as "liberation" from the confinement of his wheelchair. In his critique of an image by an artist of Hawking leaving his wheelchair, disabled BBC journalist Ellis Palmer (2018) contended that what "this image suggested was a rather damaging trope: the disabled person should always seek to not use a wheelchair, rather than the impairment being something positive to reflect and work with" (para. 24).

What I have also sketched are the potential connections among connected cars and communication that disability (in all its diversity, ambiguity, realities, lived experience, innovation, and imagining) brings to our notice. Here, also fleshing out these implication of disability's connected cars' turn for communication is something that deserves and requires future inquiry and debate.

In closing, consider, for instance, one especially important idea arising from disability studies––namely, that, as humans, we are not so much independent or interdependent. All of us depend on others, and on various support systems, including increasingly technological systems, for our lives. This is immediately applicable as a corrective to the recurrent strain in work on robotics, intelligent systems, and other technology that puts a strong emphasis on and often valorizes autonomy (Sandry, forthcoming; Seelman, 2016). This constitutive contradiction is especially salient in notions of "self-driving" or "driverless" cars or "autonomous vehicles," where the assembling of the social in such emergent technologies of mobility and communication remains largely occluded.

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