

# The Machine as an Extension of the Body: When Identity, Immersion, and Interactive Design Serve as Both Resource and Limitation for the Disabled

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## Abstract

This research explores how the technological affordances of emerging social virtual environments and VR platforms where individuals from an online disability community are represented in avatar form, correspond to these users' development of embodied identity, ability, and access to work and social communities. The visual attributes of these avatars, which can realistically reflect the user's physical self or divert from human form entirely, raise interesting questions regarding the role identity plays in the workplace, be it gender, race, age, weight, or visible disability. Additionally, the technology itself becomes fundamental to identity as the increasing use of artificial intelligence (AI), motion capture, and speech-to-text/text-to-speech technologies create digital capabilities that become part of an individual's identity. This raises further questions about how virtual world technologies can both increase and potentially create *barriers* to accessibility for individuals who find freedom in their technologically embodied surrogates.

**Keywords:** virtual worlds, VR, virtual reality, virtual identity, digital affordances, avatars, disability

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## Introduction

Massive disruption was the central theme of 2020. The emergence of COVID-19 and, in the U.S., social justice protests resulting in an increased focus on diversity, equity, and inclusion (DEI) are transforming the workplace, perhaps forever. In recent years remote work experienced a roller coaster of acceptance and rejection, but in what felt like overnight, it became the norm. As companies grapple with safe work environments moving forward, safety is a matter of concern for both the physical and emotional health of their workers. As those workers are now most often relegated to communicating via computer screens, what can we learn from the human/machine relationship in digitally embodied cultures?

This study explores the intersection of humans and technology via the challenges, as well as the innovative use of social virtual worlds (VWs), through the experience of people with disabilities (PWD) who have been working and socializing via their avatars in Second Life (SL). What we learn from the experiences of the individuals who have been highly engaged in these immersive online communities can shed important light on the human relationship with the machine as it relates to accessibility and barriers to VWs, especially as these platforms have the potential to become more common spaces for work and social activity in an era of social distancing.

As the evolution of the cyborg has often portrayed embedded and prosthetic human-machine augmentation, in these immersive and interactive online environments the machine offers, via the avatar, a digital surrogate capable of engaging in meaningful life experiences and human interaction. The lessons learned from PWD, whose physical bodies often limit their physical world interactions and opportunities, offer important insight about the importance of technological design when the machine may represent voice for the deaf, movement for the immobile, and eyes for the blind.

Consider, for example, the emergence of virtual reality (VR) environments that are increasingly realistic and accessible. While historically these environments have been used primarily as social and gaming spaces, their designers—as well as organizations such as Facebook, Google, Microsoft, and Apple—have been investing heavily in VR technology, recognizing its potential beyond social connection and entertainment. In 2018, for instance, Microsoft released a demonstration of their new voice-to-text capabilities built around mixed reality (MR) platforms and artificial intelligence (AI) for the purposes of effective meetings with remote attendees. Microsoft has also recently addressed how these technologies can “empower people by accelerating the development of AI tools that provide them with more opportunities for independence and employment” (O’Brien, 2018).

While these emerging assistive technologies have also been evolving in game platforms, their role in earlier screen-based predecessors have resulted in rich human activity and have subsequently become robust research spaces. For example, in a study of the evolving state of social VWs specifically addressing disability communities, the theme of digitally created identity consistently reveals the power of embodiment when the user is able to represent themselves in ways that may be completely different from their physical-world identity (Davis & Chansiri, 2019). The visual attributes of avatar selection raise interesting questions regarding the role identity plays in the digital environments be it race, gender, age, weight, or visible disability, especially in an era where social justice is also under intense scrutiny as a result of the movements emerging from Black Lives Matter. Likewise, in a moment when

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face-to-face contact is often carried out via screens in a “Hollywood Squares” grid of floating faces, consider how often people choose to leave their cameras off rather than expose what may be chaotic realities in a public way. With over half of the American employees working remotely at least part of the time (Gamito et al., 2020) and as workplaces consider potential alternatives in embodied immersive environments, questions emerge. How does the technological design influence the manner in which people are represented in these environments and how might those options also be performed in ways that influence social connection?

The technology itself becomes not only fundamental but serves as a function of identity with the increasing use of AI, motion capture technologies, and speech-to-text/text-to-speech technologies, which create digital capabilities that become a part of an individual’s identity. Think, for instance, how Stephen Hawking’s technologically-enabled voice “became a part of his identity.” However, the complexities of these rapidly changing technologies may also create new *barriers* to accessibility for individuals who have found freedoms in their embodied online surrogate. Barriers to access may be economic or may result from the lack of industry attention to universal design, for instance, that may not address people with dexterity issues.

A number of issues of technological design have revealed the importance of affordances of voice technology for the sight-impaired, text communication for the hearing-impaired, and the ability to choose a body that reflects a quality of their character, creativity, and varied intelligences rather than the physical attributes typically associated with visual identity and stereotypes. The implications of this embodied identity can lead to new ideals that have the ability to transcend the typical labels of the human condition that often create either advantage or disadvantage. The results of this research challenge us to consider interesting possibilities for the future of the digital workplace and social communities as new skills and technological design may create different opportunities for screen-based embodied interaction regardless of the participant’s health, disability/non-disability, social, education, racial, or geographic status.

This study seeks to answer:

**(RQ1)** How do PWD who function as avatars report the technological affordances of virtual environments as functions of online identity in support of social or professional interaction, and **(RQ2)** What elements of platform design either support or inhibit social function among PWD in Second Life?

## Literature Review

The intersection of disability, work, and technology is a complicated one as the disability community is so often left out of the discourses of equity and inclusion not only in the workplace, but in society more generally. As Goggin et al. (2017) explain, “we all have a deep stake in the operation of norms and the power relations of normalization, and that to understand these, we need to understand how disability plays into this, especially through the intertwined dynamics of culture and law” (p. 340). How disability plays into technology use and adoption speaks volumes as Pew reports that Americans with disabilities are approximately three times as likely to never go online than able-bodied people, with 61% of PWD reporting they have a desktop or laptop computer (Anderson & Perrin, 2017).

## Digital Accessibility

Online technologies have long been considered a source of both promise and peril for PWD. Although the early promises of advanced technologies were met with exuberance, research found that although most PWD reported hopes of improved independence both at home and beyond, many of those platforms never reached mass adoption (Harris, 2010). Harris (2010) reports that barriers for adoption by PWD included factors like cost—for both mainstream and “specialist” devices—and that those “specialist” devices weren’t designed or engineered by PWD. Harris (2010) concluded that “the application of advanced technology should be directed by disabled people, collectively and individually” (p. 427).

These gaps in adoption and usability may also be explained by the technology, its accessibility, and/or the many factors defined by the PHAATE framework, which consist of policy, human, activity, assistance and technology, and the environment (PHAATE) (Cooper, 2007). This model places the human element at the center of assistive technologies while also considering what activities occur in which environment. The model also separates assistance and technology, recognizing that assistance may come from technology or from other individuals. By putting the human at the center of the model, it likewise acknowledges that the human’s needs and need or desire for assistance may vary over time. This model can be especially useful when considering screen-based immersive VWs versus VR as experienced in a head-mounted display (HMD). Consider, for example, individuals who experience claustrophobia or whose neck would not have the strength to hold up an HMD.

When wearing the newest iterations of an HMD, the human audio and visual senses are essentially hijacked, eliminating external distraction of the physical world, thus creating what might be anticipated as a more powerful sense of personal, social, and environmental presence in the virtual world (Heeter, 1992; Lee, 2006). Studies in screen-based VWs have already shown that in the virtual world, the medium has essentially become a prosthetic, or a digitally embodied state of “architecture on the body” (Davis & Boellstorff, 2016, p. 2112). Using the PHAATE model, the user may have access to a screen experience but may be unable to transition to the more immersive HMD version of the same experience.

It is important to not only acknowledge the social and cultural values that are embedded into technology when considering the future of VR design, but to understand and identify affordances of human-computer interaction including physical, cognitive, sensory, and functional factors (Hartson, 2003). This includes both hardware and software design elements that affect vision, sound, ease of movement, ability to use a keyboard, and more. This is particularly important as these features will affect individuals with disabilities who use VR environments. The instrumentalist assertion that “technology is value-free” and its results depends on how humans use it, has long been contested (Eco, 1994). As Feenberg (2002) contends, “when you choose to use a technology you do not simply render your existing way of life more efficient, you choose a different way of life,” which is “not simply instrumental to whatever values you hold,” but instrumental for substantive societal value choices (p. 7).

## Embodied Identity and Second Life

We note that digital inclusion (access to technology) does not necessarily equate with social inclusion. There is a long way to go before digital technologies can successfully impact

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the lives of people with disabilities, as suggested by Goggin and Newell (2003). The media effects of this embodied identity, or media as the literal extension of man, leads to new ideals of identity that offer possibilities to transcend ability, race, gender, age, weight, or perceived beauty. It is also recognized that embodied identity manifested through virtual reality also creates greater opportunity for deception through the inherent opportunities for anonymity that VR provides.

Although this concept of deception is typically associated with wrongdoing and negative outcomes, it can also be suggested that allowing one to create an identity that represents their idealized self may have positive outcomes. Recognizing that there are interesting ethical implications, mediated identity may provide opportunities for individuals historically marginalized by Western ideals of ability and beauty to find opportunities previously inaccessible to them. This points to the interesting possibilities that can emerge for the future of social communities as new skills and technological design may create different advantages and disadvantages.

Identity, for PWD in VWs is represented in the ability to communicate in text or through screen-readers in ways that do not require they disclose that they may be blind or deaf. Additionally, perhaps because the motivation to participate in VWs is often “play,” individuals can choose visual identities that reflect a realistic self-representation or an avatar that not only doesn’t look like their human form but may not reflect any human form at all. As Nowak and Fox (2018) found, both avatar agency and the characteristics afforded by an interface can influence how users engage and interact within the platform. Specific to PWD, Noble (2012) found cyberspace allowed individuals to create a “virtual social identity” that paralleled their “actual social identity” as a way to create and maintain professional and social relationships separately (p. 161). In contrast to other media such as Facebook’s requirement to link accounts to users’ real names, the typical Second Life (SL) user does not use any, or limited, physical world identification.

As stated, this study explores the experiences of disabled individuals in Second Life (SL), one of the best known and longest-lasting screen-based VWs, in order to better understand how humans utilize technology, often to engage in work and community in ways their physical worlds would not allow. Today, SL maintains a reported 800,000–900,000 active users globally who access the environment via computers and the internet (Dodds, 2020). As the platform has evolved in its 17 years, it now offers highly realistic imagery, highly stylized avatar options, and a very stable delivery with the increase in computing power and internet speeds.

## Human-Technology Experiences: Through a Phenomenological Lens

As van Dijk (2012) notes, in all mediated communication “some kind of entity is present between humans and their experience of reality,” and unlike direct human experience, which “has always been an observation of reality involving all senses *simultaneously*,” in mediated communication, there are always particular restrictions, as “the use of all senses is impossible,” (p. 235). The core characteristic of VR has been identified as in the inclusive relationship between the participant and the virtual environment, where the distinct experience of the immersive experience is constituted as communication (Bricken, 1990). Considering this through a phenomenological approach to the philosophy of technology,

technology mediates and transforms our sensory perception of reality, offering that this can occur through what Ihde (1990) calls a paradigm of amplification and reduction (Bennett, 2005; Ihde, 1990). As the mediation of certain sensory experiences are enhanced, amplified, or extended through the use of technology, Ihde contends this comes at the cost of reducing or limiting other sensory aspects of this reality. This raises interesting questions when considering immersion in VR and with an HMD regarding what aspects of reality are “necessarily” reduced in exchange for the sensory amplification that is afforded through experiences in VR, and what, if any, are the consequences of this reduction. Is this reduction experienced as an advantage or disadvantage contingent upon individuals’ abilities/disabilities?

Considering this idea in a similar vein, Borgmann’s (1987) device paradigm posits that when we increase engagements with technology and incorporate them into more facets of our life, we come to perform less and less of these tasks on an existential level as they are performed more and more by our technologies on our behalf, thus “eliminating our connection with the natural, social and material world in which we live” (Arnold, 2003, p. 241). Contrarily, other research has identified benefits from prolonged experiences in social virtual world environments such as increased social interactions among individuals whose health or disability had previously isolated them (Davis & Calitz, 2014; Kandalaf et al., 2013). Considering different philosophies of technology through a phenomenological lens may also provide some considerations for both researchers and designers of VR in future developments, both of studies and the technology itself. By considering how and to what extent technologies can amplify or reduce different sensory experiences, coupled with considerations of human-centered design factors, future developments can be designed with inclusivity in mind, reducing barriers in favor of accessibility.

## Method

This study explores the interplay between technological design and affordances of VWs and PWD who utilize these technologies to create online personas as a way to access and participate in online communities. A qualitative multi-method ethnographic approach was utilized in order to better understand the cultural phenomenon when little is understood about the systems, functions, and beliefs unique to that environment (Lindlof, 1995).

This research emerges from an ongoing 3-year ethnographic study in the virtual world Second Life (SL) that explored embodiment among individuals living with any number of physical, emotional, or developmental disabilities. Study participants were recruited from a number of existing communities within SL focused on different disability issues resulting in participants with issues ranging from autism, epilepsy, post-traumatic stress disorder, bipolar disorder, visual and auditory impairment, multiple sclerosis, and cerebral palsy to various illnesses leading to long-term disability such as Parkinson’s disease. Participants ranged in age from 20–60 years old. The research included extensive virtual-world participant observation, more than 170 hours of regularly scheduled informal group discussions, chat log analysis, and more than 20 hours of in-depth interviews. People were invited to engage in either voice or text and all discussions included both text transcription and voice narration to make sure people who were deaf and blind could be included in the conversations. From the group discussions and interviews, a number of themes emerged,

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including the technological issues with the interface as reported by a number of people in this community. Subsequently, we hosted four gatherings in cooperation with the leaders and developers of the primary viewer used to access the virtual world (called the Firestorm viewer) and the leaders of an organization called Virtual Ability, Inc. on Virtual Ability Island (VAI). “Virtual Ability® is a non-profit corporation that enables people with a wide range of disabilities to thrive in online VWs” (Virtual Ability, Inc., 2020). The organization has been active in SL for more than 12 years and has supported more than 1,000 members with educational, social, and entertainment opportunities.

This study received Institutional Review Board (IRB) approval. All interviews were recorded, transcribed, and saved to protected databases, and all avatar identities were anon-ymized.

Focus group chat log transcript and group (N = 34) membership profile data was coded through inductive and interpretative case study reasoning informed by Grounded Theory and phenomenology (Corbin & Strauss, 1990; Reid et al., 2005). To answer RQ1, manual coding of text chat logs from both group discussions and in-depth interviews were analyzed to determine common themes about identity as it related to both the technology and its relationship to work. To address RQ2, this process was also then completed for the four additional focus groups (N = 40) specific to the technological attributes that either created or hindered accessibility in this immersive virtual life world.

Inductive content analysis from a series of focus groups on identity and its relation to work and community engagement revealed insights into the effect avatar identity had on work and social interactions. In-depth interviews drilled deeper into the common frames of key identity and technological attributes of the platform to better understand the community’s relationship with the technology, with work, and with each other. These interviews represented a purposive sample, conducted with individuals from the Virtual Ability group who had been highly engaged in activities and communities in SL and who had become leaders in the virtual world.

Note, because the interviews were conducted in private and are not available anywhere online, the text chat was left as written rather than corrected for typographical and grammatical errors. Also note, “RL” is often used to represent “real life” which is otherwise referred to as the physical world throughout this paper.

## Results

In response to RQ1) How do PWD who function as avatars report the technological affordances of virtual environments as functions of online identity in support of social or professional interaction, the following themes emerged:

### **Avatar customization via age, gender, and specie to create social and work identity**

Although common themes of identity consistently emerged, specific themes pointed to users’ ability to make choices and personalize their avatar specific to the role of users’ engagement in work in the virtual world. It is important to note, avatar appearance in SL is very easily and highly customizable, with a marketplace of more than seven million products

available on the SL Marketplace (Second Life Marketplace, [n.d.](#)). Likewise, many of the participants are also content creators and would “build” items to wear. The following examples reflect the complex experience of choosing an avatar specifically to address work identity with both physical- and virtual-world implications. These identities conveyed agelessness, gender, and avatar specie. Although age is relatively non-descript in these environments as the default construct of the typical avatar is a young adult and, as such, was not considered a measurable attribute. It did, however, appear to have an important influence on work.

Avatar A explained, “i find sl to be an enabling environment for being able to be productive as a person with a severe mental illness disability.” Of particular interest, because she experiences an “invisible disability,” she has also created what she calls a “brain sling.” She explained, people can be very cruel and accusatory when people have a disability you cannot “see.” As such they are less likely to be compassionate when she needs accommodations. Her avatar’s brain sling is her way of creating a visual way to express she’s being challenged by her disability. She also describes her avatar as her “ageless self,” explaining she forgets her age until she gets up from the computer to move. She also explained that because she was attempting to reconstruct what she felt she had lost as a result of her disability, it was “especially important to represent myself as close to myself in rl as I can.” She has found great satisfaction and confidence through what she defines as “work on a voluntary basis” and in the image of herself before her diagnosis.

Gender identity was also important to a number of our interlocuters. One in particular discovered an interest in fashion in the virtual world and was offered an opportunity to write for a popular fashion blog. She created a male avatar as the digital equivalent of a ghost writer to become a very successful male fashion blogger. She only utilizes her male avatar for this work, believing she is more credible as an expert in male fashion when she is in her male form.

The third major theme, avatar specie, was another very popular choice among the studied participants. One in particular explained that she chose a gecko avatar as a way to avoid a gender identification altogether. Yet another created a talking sunflower because it made her feel “cute.” Both of these individuals described a sense of liberation in their interactions with others as they feel they are not marginalized by their gender or by the human representation of their visible disability.

Although these visual attributes defined their identity, equally important was how their identity was inextricably tied to performance as influenced by the technological design. For example, just as individuals in professional environments who may have difficulty spelling or experience learning disabilities often rely on spell check and grammar checkers to avoid ridicule or the appearance of incompetence, the built-in functions of the platform influenced their interactions with both work and social others. This finding intersects with RQ2.

In response to RQ2) What elements of platform design (affordances) either support or inhibit social function among PWD in Second Life, several themes emerged consistently including:

**HCI affordances: physical, cognitive, sensory, and functional** (Hartson, 2003)

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These specifically included hardware issues, software issues, sustainability, voice-to-text/text-to-voice capabilities, American Sign Language (ASL), flexibility of the coding and menus, navigation and movement, the use of pre-programmed “gestures,” and issues around vocabulary and inventory management.

## Hardware

Norman (1988) defined affordances as the relationship between the properties of an object and the capabilities of the agent that determine how the object will be used. Perhaps hardware and software design are most core to this concept of affordance. The hardware itself was a challenge for some. A woman in the community who is an arthritic wheelchair-bound little person explained:

“I’m a bit worried about VR and the size/weight of VR goggles, and the amount of neck movement they would require” “): because i have so much issue with my left hand not being strong enough to consistently hold down a key such as shift - not arthritic little person friendly I suspect “i got a bowling wrist brace and using a hanger my brother is fixing a button pusher :P”

Similarly, there was extended discussion about keyboard and mouse design. Many of the individuals in this community struggle with dexterity and as one proclaimed, “changing mouse sensitivity is a limited solution” and another lamented, “but track balls can destroy a thumb.”

## Software

Although the discussions were built around the design and content of what is called the Firestorm viewer, many of the people in this community utilize two platforms called Rade-gast and Restrained Love Viewer (RLV). Rade-gast is a non-graphical client that was designed for low performance computers. However, the blind community has used it as a screen-reader in a way that supports their navigation through an otherwise very visual medium. Similarly, RLV was designed for the Bondage, Discipline, Domination, Masochism (BDSM) community as a control feature, but the blind have discovered its value as a way to remain connected to another avatar while navigating the virtual world. These software applications have become invaluable, yet Rade-gast was developed by an individual who also managed the program independently and voluntarily (rather than as a profit venture). When the developer died, it left the community in crisis as maintenance of the program was left unat-tended, leading the conversation to the issue of sustainability.

## Sustainability

In the discussion of Rade-gast, one of the design engineers was in attendance. In support of her effort, one participant explained, “She has donated her time and has continued the project that Latif left unfinished when he passed.—CINDER IS the reason Rade-gast still lives.” The hope of this community, they said, was sustainable financial support via “ways to set it

up to be owned and maintained by a foundation of interested folks, but it is important to consider the question of maintenance and long-term ownership up-front before and after development begins.”

### **Voice-to-Text/Text-to-Voice Technology**

Perhaps the most important or dominant theme among this community was accessibility to voice-to-text and text-to-voice features and as one of them explained, “Voice-to-text and text-to-voice would be beneficial to many more than just those with vision impairments . . . and are not adequate for them.” As they discussed the need for colored fonts and magnification features, the conversation revealed that those features already exist. Several of the people in the community simply weren’t aware of them. As the discussion continued, they pointed out that color schemes would also assist the deaf community and yet it would also create new challenges for the colorblind. They concluded, “we need to do a LOT of educating of all the builders and developers and creators here about accessibility features . . . but that is beyond the scope of this brainstorming.”

### **Incorporating American Sign Language (ASL)**

For the deaf community, the hope was summed up in one statement: “an ultimate DREAM is to see ASL between avatars in world.” Although strides have been made in other technologies such as Leap Motion that can capture hand motions and Sansar, a 3D social virtual world designed for HMDs with extremely accurate motion capture, none of these technologies are currently ready for ASL. One participant sarcastically joked, “you can make your sign language system to work with the ao [animation override] now and just run it on Firestorm lol.”

### **Flexibility Without Too Much Complexity**

The frame of flexibility was also strong in the discussions. For example, one person wrote, what would be “helpful with viewers is building in flexibility. Like making the text larger or smaller, allowing different color schemes, those kinds of flexibility . . . so that you can tailor it to your personal needs.” Yet, they also worried, “too much complexity because of too much accessibility can make it inaccessible.” Another explained:

“im asperger and dislectic lol - not sure what I am using as assitive technology for sl - perhaps reading back chat - and sometimes autocorrect- but most get my “badtyping’ etc -perhaps contrast settings in the screen and also finding a good font to read ` - Not being the dislectic font cuz that dances in fornt of my eyes - I am using firestorm which alowes more seetigns then then standard sl vieuwer”

### **Gestures**

For the nondisabled users, one popular feature in the social virtual world is the use of gestures. These can read like, “\*:-,\_,.-:\*’`’’\* HOWDY! YA’LL \*:-,\_,.-:\*’`’’\*.” However, it was explained by the deaf community that “the gestures that draw pictures from ASCII

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characters that are then read aloud, character by character, by screen readers” create very complicated experiences for the deaf community. They also reported, “Gestures are also often a ‘trigger’ for PWD with certain issues.” Another suggested, “Hmmm is there such a thing as an icon translator? For instance, I don’t “get” those typed icons which are mostly parentheses . . . could they automatically translate to words I could understand?”

## **Movement and Navigation**

One blind participant explained, “Navigation is a huge issue for those of us using RadeGast.” The software developer in the meeting indicated that effort is being made to create easier “navigation, like the ability to follow roads or paths.” Another reminded the group, “OK here’s another RLV adaptation . . . how to allow the guardian of a person with low intellectual capacity to set limits on their viewer.” And another suggested, “it could be useful to have a hud that would put a blind person in the sighted guide position and moved along with another avi.” Yet another suggestion was tactile feedback for navigation. He explained, “just like you do when you play a race car game with a steering wheel and can feel the impact of bumps on the road and such, why not have similar feedback through a joystick or game pad so we can feel where we’re moving?”

## **Vocabulary and Inventory**

The final frame that was consistently reported by the community was centered on issues regarding vocabulary and inventory management, for example: “it is important to think about the words used . . . why does “home” mean at least three different things in here. That can be confusing. See if we can pick better words for some of those.” It was explained that inventory items are named “item” by default and if the creator is unaware, many items placed in the environment are called item—again creating not only an issue with identification but with navigation as well for people using screen-readers.

Interesting parallels of disability/non-disability were discovered and discussed as a result of the technology. In other words, the technology could create a sense of disability, as explained earlier by a woman with Parkinson’s disease when she discussed attempting to move in the virtual world when there was lag. “Lag” mirrored her experience of being stuck (or frozen gait) as a result of her Parkinson’s. Additionally, logins and voice capabilities can fail; although some could hear each other’s voice, audio for others may be unavailable.

Another frequent technical glitch is excessive time required for images to load. When these challenges emerged, people would often suggest that the failure of technology mirrored challenges many of the disability community experienced in their everyday lives.

Another phenomenon that emerged was the importance of human interaction and the tendency to teach each other and provide collective support with interesting hacks. For example, one participant shared,

“you know when I go anywhere in any grid, because I have voice turned off I don’t see the voice dots or any sort of indicator that tells me that people are using voice instead of text—I think that would be kind of nice, a visual clue that people are talking instead of typing so I know if i’m missing something.”

Another reminded the group, “We need to remember that all computer OSs have accessibility features. Use them!” These tips and shortcuts could help these individuals function more efficiently throughout their activities, resulting in higher levels of reported satisfaction and confidence in their interactions.

## Conclusion and Discussion

This research was part of a study of PWD in VWs designed to better understand how virtual embodiment and the human relationship with the technology creates opportunities that affect a person’s ability to engage in both work and social communities. One of the fundamental issues for these individuals in their physical world is access, or the lack thereof, not only potentially to technology, but to work and social communities. As technologies continue to improve the ability to create social, living, and work environments in digital platforms, people often assume that this will also create better opportunities for PWD. However, the results of this study reveal that while there are affordances that provide opportunity to create an online persona that foster these connections via their digital surrogates, there are also barriers to success. VWs can create “the appearance of disability-inflected elements to communication rights” that may also be “inextricably bound up with the socio-technical and cultural coordinates of the Internet and associated digital technologies” (Goggin, 2014, p. 337). These elements can be how the hardware and software design create online behaviors that can be misinterpreted. For example, in a virtual world where physical visual cues aren’t available, someone who experiences tremor and is relegated to text communication on a keyboard (rather than voice-to-text access) may be accused of being “drunk” or “stupid” as a result of a high volume of text errors.

In answering how individuals who function as avatars report the affordances of virtual reality as functions of online identity in virtual environments, perhaps one of the most important features to these individuals is avatar customization. Being able to create an idealized or fantasized self was fundamentally tied to their virtual experience and an ability to be connected in this world, even virtually. While program and platform designers continue to work toward complete visual fidelity, especially in the workplace, both the technology builders and workplace leaders may need to consider how identity may be redefined in virtual environments to best suit the capabilities of individuals who are typically marginalized by their disability or other demographics deemed compromised. This issue has also become increasingly important as diversity, equity, and inclusion issues escalate across the world. As work may remain remote for an unforeseeable future and social distancing (resulting in social isolation) continues, reconsidering what is “appropriate” or expected for online identities could have powerful consequences and result in creative solutions. Future research in this area is needed.

In the exploration of the technological affordances of these platforms for global collaboration and connection, strong evidence supports the need to include PWD in the conversations about design and implementation in the developmental stage in order to best provide adequate future access to these individuals. Beyond the call for universal design, as discussed by the interlocutors in this research, several of the technological design issues were easy fixes by coders. Additionally, several of the issues were easily teachable—in other words, communication, collaboration, and training was key.

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As also discussed in the focus group about technological design and use, one participant was encouraged by work being done outside of the specific program and viewer when he explained:

I'm going to try to explain something in my head: there are an increasing number of "microservices" out among the clouds of the internet that do useful things—speech recognition, speech-to-text, translation—and many of them are getting better and better at doing what they do. I suggest that our viewer should take advantage of those microservices rather than try to build its own version of them (which our developers would have to support, fix, extend).

Strong open-source collaborative building in a sustainable way will go a long way to provide access not only for PWD, but in a way that has often been discussed as the benefits of universal design. As one person explained, "Voice-to-text and text-to-voice would be beneficial to many more than just those with vision impairments . . . and are not adequate for them." Similarly, in the discussion of ASL, one person explained, "I know that the 'follow' function is important to people who are blind using Radegast . . . how could that be made to work more easily? I am also thinking it would be helpful for sighted users who have mobility issues and can't move their avatar readily." These revelations point to valuable tools that can make the experience for any individual more seamless and satisfying.

These insights provide direction for the development of VR technologies that have important implications, not just for PWD, but for all people. For the people in this study, the machine is in fact an extension of their body, often creating access to community and work. As organizations look to these technologies in the future of work and connection, especially through the lens of equity and inclusion, inclusion of individuals of all ability in the development of the technology will create inclusive design that is not just about including marginalized individuals, but will also create the strongest and most inclusive platforms for productivity and creativity.

Additionally, the ethics, as well as the social consequences of these new HMD VR technologies are just beginning to be explored. As developers, industry, and gaming companies continue to build more powerful and alluring experiences, this also demands that we further refine the concept of embodied social presence (Mennecke et al., 2001). Through the lens of mediated "physical" experiences—which we contend can be both enabling and/or disabling in the evolving state of social VR, the theme of embodied identity has consistently revealed a powerful effect when the user is free to create a unique digital identity (Davis & Chansiri, 2019).

While these affordances may allow for an expression of identity tied to ability, creativity, and sociability not accessible in the physical world, these technologies also create new barriers to accessibility for individuals who have found freedoms in their embodied online surrogate. For instance, challenges in technology such as lag resulting from bandwidth issues or computing power can result in what our interlocutors reveal is a mirror of their disability experience in the physical world including the case above when addressing lag—the individual living with Parkinson's disease responded, "welcome to our world." This notion of the medium as a lived human experience raises interesting questions about media effects resulting from design and accessibility in social cultural and future workplace perspectives.

## Author Biography

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