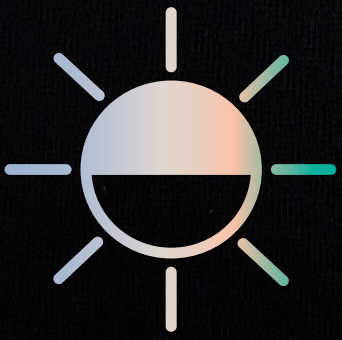

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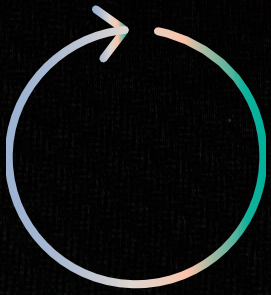

How
Digital
Debility
Reshapes
Our
Bodies

INTERFACE FRICTIONS

INTERFACE

Sign, Storage, Transmission

A series edited by Jonathan Sterne and Lisa Gitelman

FRICTIONS

HOW DIGITAL DEBILITY RESHAPES OUR BODIES

Neta Alexander

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For Jonathan Sterne (1970–2025),

who taught me how to live in a body,

impaired

CONTENTS

INTRODUCTION

Disabled/Enabled

We start from the premise of difference.

—MARA MILLS AND JONATHAN STERNE, "DISMEDIATION"

Which bodies are enabled and which are disabled by specific technologies? How is the "normative" configured?

—LOCHLANN JAIN, "PROSTHETIC IMAGINATION"

Not Your "Average User"

While millions of Americans isolated themselves during the first year of the coronavirus pandemic, I found myself sheltering in place in a rural college town in central New York State. Bored and anxious after months of lockdown, I purchased a ticket for a collection of short films featured in the online edition of the 2021 ReelAbilites Film Festival, an annual program that showcases works by and about people with a wide range of disabilities. However, my attempt to stream the films failed repeatedly because of long buffering times and sudden disconnections. While frustrating, these moments of friction did not take me by surprise. The early months of the pandemic led to a global shift to remote work that, in turn, caused an unprecedented spike in bandwidth demand and a significant rise in latency for American internet users.[1] When I refreshed my

browser in the hope of eliminating the buffering, the festival website kicked me out, forcing me to refill my login information and repeat the process of choosing a title to stream. After refreshing, trying a different browser, and restarting my router failed to solve these issues, I gave up and left my laptop on the table in my kitchen-made-office.

Once in bed, I could no longer ignore the lower back pain, headache, eye strain, and numbness in my right wrist and palm resulting from prolonged screen engagement. While these computer-induced health issues are increasingly common, I am more prone to them than other users as a result of a set of impairments.[2] I'm a "disabled cyborg," a pacemaker-equipped woman born with facial paralysis.[3] My congenital paralysis prevents me from fully closing my right eye and makes me more disposed to eye strain, dryness, and fatigue resulting from prolonged exposure to light-emitting screens. I also had Ewing's sarcoma, a rare cancer that left me with a platinum plate in my lower spine, increasing the risk for chronic back pain and forcing me to develop a set of postural changes so I can sustain multiple hours of computer use. Painfully aware of the negative effects of the always-connected life on my impaired body, I promised myself to limit my screen time the next day and immediately knew this was a promise I couldn't keep.

When I woke up in the middle of the night, I realized that the video player had automatically streamed the ReelAbilites films while I was asleep. Due to its built-in autoplay function and the limited time allotted to stream the films, I lost my ability to play them from the beginning. My sleep registered as engagement, frustratingly preventing me from watching these films while awake. At 3:00 a.m., my laptop's display was still calibrated to the warm end of the color spectrum, reminding me that its "night mode" feature, designed to filter out blue light, was automatically turned on. Both my laptop and the ReelAbilities platform kept functioning as if a human user was watching these films.

By that point, I had been teaching, lecturing, and socializing entirely online for months. As a cardiac patient, I felt a greater need to shelter myself than many. I wanted to escape my loneliness by immersing myself in the fictional worlds I found via the ReelAbilities catalog, but my desire was thwarted. This failed digital interaction made me painfully attuned to the ways in which specific design features—from the software error that made me unable to lower the video quality and thereby prevent buffering, to the built-in autoplay function that stopped me from accessing the films once they played—have produced an experience that was the very opposite of what I had been looking forward to. This was especially frustrating as ReelAbilites, which, like many other film festivals, was pushed to offer an online-only edition during the pandemic, prides itself in its investment in accessibility, offering features such as

audio descriptions, captioning, and Zoom Q&As with ASL interpreters and live transcribers.[4] Still, instead of engaging with stories made by and for people with disabilities, I was left feeling alone and bruised by moments of friction in the interface and my inability to easily fix them.

This personal anecdote encapsulates various manifestations of pain: the psychological pain of isolation as well as the physical pain of a disabled body further debilitated by the abrupt shift to a life lived almost entirely online. These phenomena are neither new nor unique, yet they were pushed to the foreground by the pandemic. As Laine Nooney observed, we cannot tell the history of computation without attending to the ways in which personal electronics broke the human body and brought with it "a world of pain previously unknown to man."[5] But some bodies are more prone to computer-inflicted pain than others.

My unique embodiment and life experience, for example, created a messy ensemble of capacities, limitations, and needs. As a disabled and bilingual immigrant woman, I am not the average user of digital technologies. Since the rise of personal computers in the 1970s and 1980s, the "average user" of computational technology has been imagined and studied as a male, white, able-bodied, native speaker of English.[6] This fictional, "techno-chauvinist" idea mirrors the lack of diversity among web designers and software developers working across the tech industry.[7] Pushing against these trends, *Interface Frictions* focuses on non-average users, especially users with disabilities, to advance a new theory of the digital interface. The main question I seek to answer is how interface design creates contemporary conceptions of ability and disability. To do so, I study four ubiquitous design features and the respective mode of media consumption they are designed to produce: refresh and seamlessness, playback speed and speed watching, autoplay and binge-watching, and Night Shift (i.e., auto-dimming) and soporific media. These interface features are increasingly pervasive parts of daily life spent using the internet, yet they remain understudied, as scholars and users tend to ignore the ways design decisions have come to shape embodiment, temporality, contingency, and immersion.

The interfaces through which internet users interact with stories, information, and each other often perpetuate a hegemonic, able-bodied user position. As such, they create and encode inequalities of access to media and information, even when used for circulating films and television shows committed to inclusivity and social justice. Drawing on the work of disabled designers, filmmakers, artists, scholars, and activists, I historicize the four features I study by mapping the gap between their initial, stated goals and their short- and long-term effects once they became an industry standard. This is achieved by conducting interviews with software engineers and accessibility consultants, and

by excavating design histories based on tech blogs, press releases, users' forums, and the Internet Archive. Drawing on these sources, I paint a detailed picture of how design features come to shape the lives of their users and rediscover the design alternatives they erased overnight. These roads not taken reveal how design decisions incrementally reconfigure ideas about the "normative" body.[8] From thumb-based gestures to autoplay and sleep apps, I explore how the omnipresent interfaces of our digital lives both offer relief from and potentially contribute to disabling conditions.

When we trace the origins of interface design features, non-average users emerge at every turn. Blind people developed sonic and tactile ways of communication that challenge the rise of *thumbification* through repetitive, thumb-based micro-movements of refreshing, swiping, or scrolling (chapter 1). Blind and Deaf users pioneered ways to compress time and control the playback speed of media, paving the way to speed listening and speed watching (chapter 2). Netflix subscribers who struggle with invisible disabilities like post-traumatic stress disorder (PTSD), depression, and suicidal ideation have successfully pushed the company to add the option to opt out of its autoplay feature (chapter 3). Digital users who struggle with insomnia, chronic fatigue, and other sleep disorders are central to understanding how light-emitting screens impact circadian rhythms (chapter 4). The human body is implicated in the ways we consume media, and thus the ways different users are watching, listening, and otherwise navigating cyberspace are crucial for any historicization of the digital user.

Interface Frictions moves beyond existing accounts of "usability" or "access" by bridging media studies, interface design, and critical disability studies.[9] This interdisciplinary approach is in debt to recent attempts to study media through the lens of disability. Advancing a theory of "dismediation," Mara Mills and Jonathan Sterne scrutinize how media produce disability not only through their ableist representations of non-normative bodies but also "through their very operations, their institutional existences, and their policy and juridical dimensions."[10] Instead of asking how we can make specific apps, interfaces, or media objects more inclusive for users with disabilities, a focus on dismediation emphasizes how these non-average users have tweaked, remade, and hacked existing technologies to better fit their needs. As such, it replaces technological determinism with a relational understanding of mediation-as-negotiation. Dismediation is also fruitful for my historical analysis, as it "starts from the premise of difference," pushing against the universalization of the spectator, user, or listener as male, white, and able-bodied, without ascribing value or hierarchy to one embodied position over another.[11]

Mills and Sterne, much like a growing group of media and science and technology scholars, reject what is commonly referred to in disability studies as the "individual" or "medical" model of disability, which frames it as a problem awaiting a solution by medical experts.[12] Instead, the "social model" of disability distinguishes between impairment, that is to say, any physical or mental condition differing from the norm, and disability, which is the set of barriers imposed on people with impairments that make it harder for them to navigate the world.[13] While limited mobility does not necessarily lead to, and is not necessarily experienced as, a form of disability, the lack of curb cuts or elevators might prevent wheelchair users from working or socializing outside their home.[14]

To use a less familiar example, my facial difference is an impairment that, under specific conditions, I might experience as a disability because of the growing ubiquity of biometric technologies that encode certain assumptions about the so-called normal human face. In a world in which facial recognition is increasingly used as a security method, from opening one's iPhone to skipping the lines for border control in most Western airports, my asymmetrical smile and the minor discrepancy between my eyes might prevent me from boarding a plane, using a smartphone, or accessing my bank account. This, however, does not result from my congenital difference; it is produced by the quantification and algorithmization of faces. Translating a set of features such as eyes, nose, and mouth into the probable distances between pixels transforms face recognition into a mathematical problem: "Eyes" are nothing but the distance between two or more darker pixels in an image. The algorithmic systems supporting this biometric technology, however, have been trained on datasets of mostly white, symmetrical human faces, making its widespread adoption potentially disabling for people with darker skin tones or, as in my case, facial paralyses.[15] This distinction between impairment and disability is key to understanding how prevalent norms about the shape, limitations, and needs of human bodies might create ableist physical and, as we shall see, virtual environments.

This example can also help us understand the potential limitations of the social model of disability and adopt instead the "political/relational model" introduced by Alison Kafer.[16] Critiquing the depoliticization of impairment and pain in both the medical and social models, Kafer reminds us that, much like disability, "impairment doesn't exist apart from social meaning and understandings."[17] Due to its focus on accommodation and design solutions, the social model also limits our ability to imagine radical futures in which both impairment and disability are understood as political, contextual, collective, and perpetually in flux. Training biometric technologies on more inclusive

datasets, for example, might make it easier for people with facial differences or a dark skin to use them. Yet these technologies are likely to be employed to support and expand the police surveillance of marginalized communities, especially people of color.[18] What happens when assimilation contributes to, rather than dismantles, harmful and discriminatory systems? And is it possible to collectively imagine a future rejecting the dystopia promoted by for-profit tech companies and political fearmongers?

Instead of making capitalist institutions and ways of life more accessible to people with disabilities, both the political/relational model and the Disability Justice movement ask us to resist such ableist norms as the need for constant surveillance, measurement, and optimization of the human body.[19] Through a Disability Justice lens, access should not be treated as a "self-evident good" and, instead, should be interrogated to ask, Access to what and for whom?[20] Both models seek to move disability discourse from a single-issue framework to an intersectional analysis of systems of oppressions, in order to reimagine and rebuild more sustainable and community-based worlds.[21]

Advocates of the medical model might try to surgically fix my facial paralysis, while the social model can outlaw the use of biometric technologies trained on a non-diverse dataset of faces. The political/relational model of disability justice, on the other hand, can be used to question and challenge the underlying assumptions supporting a "security theater" that seeks to mathematically distinguish between "suspicious" and "non-suspicious" faces in order to imbue white, Western travelers with a (false) sense of safety while traveling.[22] In short, instead of asking how we can make biometric technologies more inclusive, we should ask, Who is using these technologies, and can they be employed in ways that do not replicate the sexist, racist, and ableist ideas that made their existence possible?[23]

These tensions between assimilation and resistance have made critical disability studies a growing, vibrant, and varied discipline. It is now practically impossible to offer an agreed-upon definition of the term *disability*, which attests to the challenges of any attempt to write a history of interface design from the perspective of users with disabilities. Yet, as I hope to make this work accessible to computer historians, media scholars, web designers, and others who have no previous knowledge of critical disability studies, a definition—rather than *the definition*—is necessary. Here I would like to follow in the footsteps of Elizabeth Ellcessor, who conceptualizes disability as a spectrum rather than a prescriptive, stable category of identity politics.[24] Drawing on her pioneering work on ableism and interface design in *Restricted Access* (2016), I will use the term "disability" to describe "any physical or mental condition that makes it difficult, if not impossible, to utilize default social, institutional, or

physical structures without some form of accommodation."[25] The digital interface, I argue, is a techno-social structure designed to exclude some users while accommodating others.

By isolating moments of friction, rather than immersion, each chapter in this book unpacks the "ideal user position" that a design feature seeks to produce as well as the affective rupture from which we can better understand who is being excluded from using it.[26] My goal is threefold: First, to develop an interdisciplinary framework that explores the underlying assumptions and embedded fictions of some of the most pervasive design features found in internet interfaces. Second, to counter these fictions by revealing the frictions caused when diverse human bodies interact with interfaces whose logic and infrastructure remain strategically hidden. Third, to describe users with disabilities as figurative canaries in the coal mine, because their experiences in navigating interfaces not made to accommodate them can help us explore the unpredictable, counterintuitive, and uninterrogated effects of interface design.

Understanding these effects is especially urgent at the moment in which some of the most common design features become habitual and therefore invisible to end users. While users rarely pay attention to small changes in the interface, such as Netflix's decision to add a playback speed feature or to shorten its countdown before automatically playing a new episode, these design choices have an accumulative effect felt in their bodies. Taken together, the features I study habituate users to ignore their biological and emotional needs. Technologies touted as pleasurable, on-demand, democratizing, and empowering effectively promote an ascetic ideology by which the human body is either generalized as male, able, and white—or is ignored altogether. I use the term *ascetic* to conjure how digital technologies recast biological needs such as sleep, rest, movement, and nourishment as obstacles to screen engagement and enhanced productivity. Pushing against techno-utopian discourses of infinite growth and acceleration, critical disability studies return us to the lived, embodied, precarious, and singular experiences of bodyminds. These bodyminds have limited and fluctuating levels of energy, or "spoons," to use a disability studies concept I will explore in chapter 4, as opposed to bodiless minds that can be uploaded to the cloud and live happily ever after (or until the fossil fuels needed to sustain ubiquitous data centers make this planet uninhabitable, and new data farms are built on Mars).[27]

When users repeatedly ignore their bodies, they become more susceptible to *digital debility*—the slow and unrecognized ways in which digital technologies inflict harm on human bodies. To understand how digital debility has come to shape our lives regardless of our unique set of capacities and impairments,

we need to study when and under which conditions ubiquitous technologies might produce physical pain, addiction, and lethargy.

A Theory of Digital Debility

While users shape technologies, technologies also shape their users. Desktop computers, laptops, tablets, electronic readers, and smartphones are all postural media conveying the world via a set of repetitive micro-movements used for human-machine interaction. Vision problems, wrist pain, "text neck," and a host of other health issues are all "the embodied human residue of natural interactions between light, glass, plastic, color, and other properties of the surrounding environment."[28] The negative effects of ubiquitous computing on the human body, however, are either ignored or flaunted by avid gamers and tech workers as a source of pride.[29] Yet what might happen if we took these incremental bodily modifications as a necessary condition of our growing dependency on screens and the limited postures and muscular movements they impose on their users? By offering a theory of digital debility, I challenge the binary distinction between disabled and able bodies. If the user suffers from pain directly produced by the daily encounter between their body and their devices, this oft-denied reality requires a theorization putting embodiment, capacity, and debilitation at its center.

Debility and disability should not be used interchangeably. I borrow the term "debility" from Julie Livingston, who introduced it to highlight "how fundamental social, moral, and biological dynamics are grounded in experience as people struggle to marshal care and rework meaning and lives within and around bodies that are somehow impaired or different."[30] Focusing on bodily impaired miners in Botswana, Livingston argues that not all impairments are recognized as a disability by either the impaired person, their employer, community, or state in which they reside. When working in a mine in which some impairments are not only common but expected, both employees and employers describe the temporary or permanent loss of capacities or mobility as normal. But who has the capacity to define normalcy and its boundaries?

Seeking to answer this important question by drawing on Livingston's research, Jasbir Puar further extends the category of debility to reveal the "violence of what constitutes 'a normal consequence.'"[31] Focusing on marginalized populations such as Botswana's miners (Livingston) or Palestinians living in the Occupied Territories (Puar), these theories disrupt the category of disability by asking who is able to employ it to access state support, communal legibility, institutional care, and other resources. For Puar, debility is a process that "foregrounds the slow wearing down of populations instead of the event of

becoming disabled. While the latter concept creates and hinges on a narrative of before and after for individuals who will eventually be identified as disabled, the former comprehends those bodies that are sustained in a perpetual state of debilitation precisely through foreclosing the social, cultural, and political translation to disability."[32]

Livingston and Puar focus on the social, institutional, and geopolitical conditions that might lead to mass debilitation of marginalized communities. Their distinction between disability and debility, however, is also useful for reassessing the material conditions and daily rituals shaped by technological dependency. The interface, I argue, is part of a techno-social system of debilitation that is normalized, expected, and tolerated by the neoliberal cultural imaginaries of the internet as an emancipatory, consumer-based, and disembodied playground. While the features I study do not necessarily produce debilitation, I will show how they work in tandem to sustain a digital economy based on pain, compulsion, and fatigue. This analysis promotes a twofold understanding of digital debility: on the one hand, as a form of discrimination preventing some groups of marginalized users from accessing and navigating digital tools and, on the other hand, as a pervasive phenomenon among some of the most privileged groups in Western society: white-collar workers, tech workers, and the creative workforce. While I do not imply a similarity between these workers and the populations studied by Livingston and Puar, their focus on debilitation is a productive starting point from which to unpack how and why some impairments and injuries have come to be normalized.

Studying debility as an ongoing process can help us shed new light on the uneven distribution of computer pain throughout the chain of supply and demand. American white-collar workers are prone to different kinds of pain than underpaid workers in the Global South who are forced to labor in order to support the growing demand for hardware, microchips, and minerals required to build smartphones and computers. Still, these entangled circles of pain reinforce each other, as more extended and frequent dependency on technology necessitates the acceleration of both manufacturing and disassembling. Electronic waste, which exposes underpaid workers to acids and other toxins due to their dangerous proximity to disassembled hardware, can lead to disabilities such as chronic illnesses, birth defects, and infant mortality.[33] White-collar workers, on the other hand, are subjected to much more gradual, debilitating conditions caused by repetitive micro-movements and sedentary lifestyles.[34] Such comparisons can reveal what constitutes a "normal impairment" in different occupations, classes, and locations. The pain necessary to support the digital economy is experienced differently by content moderators tasked with watching

graphic violence and torture videos in order to keep the internet safer for social media users and by Amazon warehouse workers reliant on cannabis oil "to numb anxiety and deaden the crushing workload."[35] The manufacturing, distribution, and usage of personal electronics are mired with pain, yet these multiple forms of discomfort, agony, and, in the worst cases, life-threatening labor conditions are seldom acknowledged by tech companies or end users. To study them in tandem through a framework of debilitation is therefore an important first step in mapping, politicizing, and resisting the ever-growing frequency of computer-based injuries.

Endlessly expanding the category of disability, as Aimi Hamraie warns, might lead to a "post-disability ideology" that risks denying the very real discrimination people with disabilities still face.[36] This is where the distinction between disability and debility is once again useful. While this book is invested in Hamraie's idea that "disability itself is a valuable way of being in the world," it wishes to uncover how technology can increasingly diminish bodily functions and capacities in ways mostly ignored by both users and scholars.[37] Rather than arguing that every internet user is either disabled or soon to be disabled, I explore the radically different embodied and cognitive experiences of users while attending to the incremental effects of technologies hailed as empowering, assistive, and liberating.

To this end, I offer three axes through which to study digital debility as inherent to the design, infrastructure, and economy on which the internet is based:

1. **Computer pain as "consensual impairment"**: As a direct result of the growing popularity of personal computers in the 1980s, vision problems and eyestrain became frequent symptoms of computer use while keyboard- and mouse-induced repetitive strain injury (RSI) "has attained the semi-official status of an 'epidemic' among computer users in Europe, Canada and the United States."[38] As demonstrated by Nooney, screen-induced pain is the result of the unnatural, repetitive, and sedentary bodily postures imposed by the personal computer: "Unlike television viewing, which is done at greater distance and lacks interaction, monitor use requires a short depth of field and *repetitive* eye motions."[39] The proliferation of smartphones and social media in the past two decades has made it increasingly impossible to balance computer use with the user's need for rest, exercise, and sleep. Despite the invention of ergonomic chairs, modular and motorized standing desks, and new physical therapy treatments for those suffering from lower back or neck pain resulting from extensive smartphone use, the shift to remote work during the pandemic

pushed to the extreme a decades-long trend of broken bodies tethered to glowing screens.[40] This is even the case when the very same technologies are touted as an easy, personalized way to treat and prevent bodily harm by using exercise apps and trackers, to connect with a medical expert via telehealth service, or to find others with rare conditions via online communities and support groups on social media. As a growing number of studies demonstrate, while these technologies can have proven benefits, they reinforce a technological dependency that makes opting out or limiting their use all but impossible.[41]

If some workers, such as content moderators, are required to spend hours in front of computer screens, how can we account for those who seemingly have more choice over their screen engagement? The prevailing willingness and eagerness of computer users can be partially explained as "consensual impairment."[42] In his study of noise and audile techniques, Sterne explores how people often subject themselves to painfully noisy environments, such as airplanes, public restrooms equipped with high-powered hand dryers, and live music venues, out of habit or simply to follow social and cultural norms. This kind of "audile scarification" is both normative and consensual, as it is "tied to spaces designed for people to inhabit."[43] For Sterne, it is "consent in the sense that people are going along with the scene rather than rebelling or exiting."[44] Despite the rising popularity of digital detox workshops and the "slow computing" movement, the vast majority of internet users have yet to try to live meaningfully off the grid or to rebel against surveillance capitalism.[45] By continuously using electronic devices, users partake in a system of consensual impairment through which their bodies are forced to sustain repetitive muscular strain. While it is possible to avoid music venues or construction sites, living without the internet is becoming increasingly impossible in an age of smart cities, digitization, and automation. This, as Sterne stresses, complicates our understanding of consent in relation to ubiquitous computing and its harmful bodily effects. Users do not choose to harm themselves; they are living under conditions of bodily impairment that they cannot opt out of.

For computer pain to become consensual, such injuries had to be normalized and tolerated for decades. The lack of public debate, warning labels, or successful regulatory efforts to hold designers and manufacturers accountable for debilitating injuries extends decades of erasure and disembodiment. Even when an impairment is identified, users are seldom compensated by the tech companies manufacturing the software and hardware that were likely to cause their injuries. This inability to translate debilitation into the legally binding category of disability can be traced back to hundreds of product liability suits

against keyboard manufactures in the 1980s and the 1990s. Despite "a causal relationship between typing and RSI," these legal attempts remained mostly unsuccessful.[46] Studying these lawsuits, Lochlann Jain concluded that "the very category of what counted as an injury, of that which was culturally legible as unjust, compensable or avoidable is shown to be not only contentious, but literally illegible—medically, legally and socially—for much of the century."[47] This is a result, in part, of the "long 'incubation' period" of computer-related injuries and the difficulty of linking them to a specific cause or event, which prevented the injured from suing due to statutes of limitation.[48] That those who were most likely to suffer from RSI were female office workers tasked with typing reveals debilitation to be gendered and class-based. In court, women were asked to prove not only that the repetitive use of keyboards led to their debilitation but that "their bodies were 'deserving' of compensation."[49] A sexist culture sought to deny the dangers of pink-collar, highly gendered labor by casting the clerical and secretarial workforce as disembodied parts of the interface. Seen as an extension of their machines, women were told that their role is to optimize and automate the production and dissemination of data mostly produced by their male employers.[50]

While computer use has since been masculinized and reclaimed by geek culture and the tech industry, many of the issues explored by Jain still require our attention. Seen as consensual or even enthusiastic, the human-machine relationship cannot be easily translated into legal frameworks. Computer pain is still underrecognized or is discussed as avoidable, minimizing the very real muscular, cognitive, and bodily changes produced via daily reliance on monitors, touch screens, and personal electronics. Common RSI symptoms like "intense pain, prickling, stiffness, anesthesia and paralysis" are either belittled or attributed to misuse or overuse.[51] By normalizing the addictive design of personal electronics, tech companies have effectively laid the ground for the widespread acceptance of the consensual impairments correlated with their daily use.

Once again, focusing on people with disabilities can help us complicate these decades-old debates. Relying on digital tools like text-to-speech or Zoom for connection, education, and remote work, the experience of immunocompromised or homebound patients makes the study of computer pain more urgent.[52] People with disabilities are also more likely to depend on medical apps and telehealth services, forcing us to reconsider questions of privacy and consent while offering ways to mitigate the short- and long-term debilitating effects of lives lived mostly online. Attending to physical and emotional mani-

festations of computer pain, the following chapters build on a plethora of lived experiences to repoliticize and reembody the user, pushing against the violent erasure of the human body and its limitations.

2. **Technology as addiction**: That digital technologies, especially social media, are strategically built to maximize "time-on-device" is crucial for producing and sustaining consensual impairment.[53] As I study in chapter 1, the pull-to-refresh gesture exploits an intermittent reward model based on providing a release of dopamine at seemingly random intervals. The strategic unpredictability of this nascent feature habituates users to constantly refreshing their mobile phones by moving their thumb from top to bottom. This dopamine-seeking behavior supports the prevailing business model of "captology"—a set of design features built as "traps" that are aimed at captivating users and maximizing their screen time.[54] Features such as autoplay are also part of this trend because they automate both the video stream and the user's engagement with the interface (see chapter 3). The need to navigate online worlds via a series of micro-decisions and endless choices produces lethargic subjects who are more likely to become "captivated" by digital platforms.

Drawing on Natasha Dow Schüll's ethnographic work on casinos in Las Vegas, I read the human-machine interactions produced by the digital interface as creating a "machine zone" that "can suspend time, space, monetary value, social roles, and sometimes even one's very sense of existence."[55] Gamblers, Schüll demonstrates, are driven not by a desire to win but rather by an impulse to extend their experience of flow vis-à-vis a synergy with the slot machine. Much like refreshing, which is designed to continue one's session in face of disconnection, boredom, or anxiety, gambling offers a stultifying repetition that, in turn, help the gambler to "gain exit from the self."[56] Pushing against the gambling industry's suggestion that only those gamblers who are predisposed or mentally disordered might develop unhealthy behavioral patterns, Schüll is careful not to pathologize the so-called problem gambler. What she offers instead is to interrogate whether "the problems are in the product, the user, or their interaction."[57] Similar to Kafer's political/relational model of disability, which shifts our attention from the individual to their environment, Schüll studies addiction as the result of "repeated interactions" between humans and machines strategically designed to exploit cognitive, psychological, and biological vulnerabilities in order to maximize profit.[58] Designers are a key part of this process, as they "inscribe" machines with specific "scripts" that limit or direct the end user.[59]

The complexity and number of agents involved in the gambling industry—designers, gamblers, casino owners, regulators, and others—remind us that the metaphor of addiction cannot be easily expanded or employed. Tech addiction, which has so far not been translated into any medically recognized diagnosis, is especially problematic for several reasons. While numerous studies connect heavy computer and smartphone use to a host of mental health conditions, including depression, anxiety, and attention deficit disorder, the term "addiction" has been critiqued as misleading because of the many differences between substance abuse and internet use.[60] The *DSM-5*, the latest edition of the psychiatric community's authoritative diagnostic manual, includes a new potential diagnosis dedicated to "internet gaming disorder," yet the editors were reluctant to add an "internet addiction" diagnosis.[61] As summarized by Ido Hartogsohn and Amir Vudka, "while recreational drug use is an 'opt-in' technology, smartphone use is an 'opt-out' technology because it is inescapable and ubiquitous."[62] In the age of remote work, the boundary between healthy, necessary, and required use of electronics and addictive behavior is increasingly contested. To that extent, treatment of tech addiction is in line with many twelve-step programs that eschew the classic model of complete abstention from a substance, be it overeating, sex addiction, and so forth, yet still function as full-on addiction recovery programs.[63]

Instead of simply replicating the "the narcotic imaginary of media," which regards screen use as insidious and addictive, digital debility unpacks the similarities between design features like refresh or autoplay and gambling machines, with their reliance on unpredictable and random outcomes.[64] Building on Hartogsohn and Vudka, I wish to emphasize the importance of "set and setting" in determining whether a given interface feature is liberating or debilitating. In psychedelic drug research, the term is used to distinguish between variable effects of the same drug dosage on different users. These might include "the psychological, social, and cultural variables such as intention, expectation, social, or physical environment."[65] Bearing these distinctions in mind, I carefully consider set and setting when historicizing and analyzing the effects of digital design features.

This focus on user interface (UI) and user experience (UX) can help us move beyond the popular discourse that seeks to regulate or ban platforms such as TikTok or Instagram because they potentially contribute to "the mental health crisis" among American children and teens.[66] The surgeon general under President Biden, Vivek H. Murthy, called for requiring warning labels on social media platforms, stating that "social media is associated with significant mental health harms for adolescents."[67] Similar initiatives, includ-

ing the legislative attempt to ban the autoplay feature and endless scrolling, which I study in chapter 3, can open up important conversations about the use of "dark patterns" and other captivating tools. At the same time, these public debates also tend to distract from the ways in which constant use of personal electronics—rather than the content being consumed—enforces a set of cognitive strains and postural limitations that might worsen physical and emotional conditions. What *Interface Frictions* opts to do is to investigate how specific design features inscribe behavioral patterns that make opting out less and less likely and how users with disabilities develop and employ alternative models of human-machine interactions.

3. **Technology as a source of exhaustion and fatigue**: Even when users are able to limit and control their daily engagement with screens, they are still likely to binge a show, go down a social media rabbit hole, play a carefully designed video game, or engage in other activities that limit or hinder sleep. Fatigue is therefore central to digital debility in two ways. First, as chapter 3 demonstrates, addictive features like autoplay push users to ignore their circadian rhythms and enable tech companies to declare sleep as their enemy.[68] Second, the soporific media industry monetizes the lack of sleep—as well as medical conditions like insomnia or sleep apnea—in order to bombard users with "sleep-inducing" technologies and products. As I explore in chapter 4, the paradox at the heart of this billion-dollar industry is that light-emitting screens and the overstimulation caused by electronic devices are proven to impede, rather than to regulate, sleep. The sleep apps and night modes promising to eliminate or at the very least to limit fatigue in fact teach users to take their smartphones to bed. As a result, many users can only fall asleep in the safety of an expensive, customized cocoon consisting of subscription-based apps, noise-canceling headphones, sleep trackers, and access to "sleep stories" and other soporific media. These tools both assume and require weary users who are willing to pay in order to improve the quality of their sleep.

Yet digitally induced fatigue extends beyond the question of how many hours one is able to rest. For Tung-Hui Hu, "digital lethargy" is the result of the ongoing physical and emotional exhaustion produced by the sharp and unpredictable transitions between fastness and slowness, hyperactivity and paralysis, that have come to characterize digital capitalism.[69] While computational logic is associated with predictability, Hu explores the ways in which "one acts, and perhaps nothing happens, or perhaps something happens."[70] This oft-denied lack of causality is isolating to the point of eradicating any real possibility of collective action. For Hu, the digital is not a paradigm shift from

earlier modes of labor; instead, it reminds us that for many, especially people of color, stasis is a way of life, as they are still forced to ceaselessly navigate a world that, at best, is not made for them and, at worst, is hostile to their existence. If consensual impairment is crucial to understanding why people choose to engage in harmful activities, Hu centers "endurance" as the pivotal temporality of digital capitalism, claiming that the trauma of a racist, sexist, and capitalist system is in fact amplified by digital tools that normalize constant connectivity, optimization, and productivity. Both theories posit a subject whose body incrementally loses capacities through the use of ubiquitous technologies.

PHYSICAL PAIN, ADDICTION, and fatigue are not exclusive manifestations of digital debility. They draw on other, more familiar adverse effects of digital technologies, such as algorithmic bias; the use of "prototypical whiteness" in biometrics, AI, and machine learning; and the automation of racism, sexism and ableism—all urgent subjects explored by others.[71] The growing literature on algorithmic bias demonstrates how machine-learning algorithms are used to perpetuated discriminatory hiring norms, criminal sentencing, and loans and credit allocations, all of which are most likely to harm people of color and other minorities.[72]

Attending to both digital features and the algorithmic systems they are designed to conceal, *Interface Frictions* explores the role of latency (chapter 1), compression (chapter 2), automation (chapter 3), and light (chapter 4) in producing digital debility. While challenging the assumptions that are central to media theory around spectatorship, media postures, or the attention economy, each chapter concludes with an alternative imagining of digitality rooted in artworks, "crip" studies, and disability media. My hope is that these roads not taken will allow the reader to envision other paths for media use and design that could undo some of its present harms. A theory of digital debility demonstrates how technologies cripple their users, yet my engagement with "crip interfaces" invite us to hack, tweak, and reinvent our personal devices.

Cripping the Interface

Before we explore crip interfaces, we must first define both terms, especially as "crip" is a term rarely used by web designers. Throughout the twentieth century, "crip" was used as a shorthand for the derogatory "cripple." In the past two decades, however, it has been reclaimed by disability activists and scholars to connote taking pride in disability activism and worldmaking.[73] When used as a verb, "cripping" is a "critical strategy borrowed from queer studies."[74] Both

queering and cripping share "resistance to cultural homogenization," as they advocate for dismantling the binary between normal and abnormal.[75] Concepts such as "bodymind" seek to bring attention to the impossibility of separating the two, rejecting the binary distinctions between mind and matter, rationality and emotion, so-called able and disabled bodies, and even health and sickness.[76] But while the various verb forms of "crip" are frequently used in critical disability studies, this analytical framework has yet to gain a foothold in computation histories and science and technology studies.

The holistic view of bodymind, however, is especially productive because techno-utopias of decorporealization have powerfully shaped the cultural imaginary surrounding the internet, while serving to deny the extent of digital debility caused by constant connectivity. From the 1990s paeans to the information superhighway as "the great equalizer for the handicapped and home bound" to the growing popularity of transhumanism, the tech industry (and the sci-fi novelists who inspired it) have toyed with fantasies of bodiless existence for decades.[77] Tracing how the desire to conquer nature and rid oneself of one's body has evolved into a billion-dollar longevity industry is beyond the scope of this book. Yet I wish to sustain a focus on these fantasies of disembodiment insofar they illuminate why both users and science and technology scholars have treated disabilities as an afterthought or a regulatory demand. The ideal internet user, as Ellcessor contends, "perpetuates the individualism and romanticism of digital media cultures as well as a neoliberal emphasis on the self as constructed through constrained consumer choices."[78] Ableist design standards assume an ideal or preferred user position such as an average-sized man who navigates the internet while sitting in a chair and using a mouse and/or keyboard. A user, however, might also be a low-vision, bedridden woman navigating the web via a screen reader and speech-to-text software while trying to distract herself from her chronic pain. To imagine such a user can draw attention to the fragility and unknowability of the human body in ways that undermine much of the post-human logic of our current techno-worlds.

Much like the human body, the interface is a process rather than a static object. As Alexander Galloway suggested, the interface is not a seamless, neutral mediator of software; it is the "generative friction" in the "zone of contact."[79] At the heart of Galloway's theory is the idea of the interface as an "effect," a technique of mediation or interaction, and as such it is used to distinguish between different layers or materials. I draw on his analysis to expand the idea of the interface beyond the graphic user interface (GUI) or the MacBook screen to include "nonoptical interfaces (keyboard, mouse, controller, sensor); data in memory and data on disk; executable algorithms; networking technologies

and protocols; and the list continues."[80] Still, the media theorists Galloway is in dialogue with, from Marshall McLuhan to Lev Manovich, tend to assume that able-bodiedness is a preliminary requirement for full participation in techno-social worlds.[81] Rejecting this assumption, as well as the use of "prosthesis" or "amputation" as metaphors for media use, I promote a multisensorial, disability-informed theory of human-machine interaction.[82] To do so, I shift the focus from the technical stack—as explored through moments of translation between software and hardware—to the unique embodied experience of the user. What might happen when we make the impaired user the focal point through which to study how interface design reshapes the user's body? What can a postural and embodied sensitivity reveal about the media use of different, ever-changing bodyminds?

Interfaces are constantly in flux, shaping their users and reorienting them toward specific behaviors and communities. I intentionally use the term "user"—rather than "spectator" or "viewer"—throughout this book despite my focus on emerging spectatorial modes such as speed watching and binge-watching. This choice resists the ableist, Western obsession with the visual by cultivating a multisensorial sensitivity through which to study human-machine interactions as muscular, sonic, tactile, and embodied. I read the playback speed feature, for example, as central to the ability of blind Netflix subscribers to navigate and engage with films and television shows by listening to audio descriptions at higher speeds than intended by their creators. Here, watching is, in fact, listening, making the term "user" more inclusive, as my historical analysis brings together various motivations for gaining control over the speed of media consumption. This term also enables me to bring features associated with streaming technologies such as playback speed and autoplay together with features like refresh and night mode, eliding the distinction between spectatorship and other computer-mediated activities such as writing, waiting, scrolling, swiping, playing, and even sleeping.

Finally, the broad category of usership allows me to trace the effects of these features across multiple loci, from laptop screens to mobile phones. Since users constantly shift between handheld and monitor-based devices, often using more than one device at the same time and switching between vertical and horizontal screens, both media historians and science and technology scholars should follow users as they aim to shed light on habitual new media. To that extent, I read sleep apps as content-agnostic postural media. These apps, I argue, are widely popular not because they recruit A-list Hollywood stars to whisper "sleep stories" into the ears of their premium subscribers, but rather thanks to their ability to nudge users into changing their bodily position from sitting to

lying down. Employing dark colors and minimalist design, these apps extend the use of personal electronics into the bedroom (and, more often than not, the bed itself). Here, the drowsy user might start with navigating a visual interface, but if the "sleep story" is successful, they will soon close their eyes and transform into a listener. This slip between visual and sonic modes of engagement, alertness, and drowsiness is central to my analysis of digital usership.

The "user" is also a historical construct born in tandem with the GUI. In the pre-GUI era of personal computing, hobbyists were able to interact, experiment, and explore the code and its limitations by typing text into the command-line interface. The shift from the pre-mouse command line to the GUI birthed the user as we know it "by creating a user/programmer dichotomy."[83] The programmer writes the proprietary code sustaining the black box design—which, as developed and popularized by Steve Jobs' Apple, seeks to eliminate edges, seams, and screws, while making it difficult or impossible for hobbyists to fix the hardware or tweak the software—while users are invited to interact with a bright-colored "desktop" consisting of clickable folders imitating the logic and workflow of their offices. The GUI led to the rise of interaction design, a field whose canonical works tellingly include Don Norman's *Invisible Computer* (1998), as it draws on ideas of seamlessness and invisibility I explore and critique in chapter 1.[84] Touting intuitive, minimalist, and user-friendly design, interaction design promises that "the best interface is no interface."[85] The interface is thus a means to an end, a tool designed to recede into the background so that the user can become as fast and efficient as possible.

Yet even the most user-friendly interfaces replicate hidden assumptions about who this user might be. Take the hand pointer, which was developed by Susan Kare in the 1980s for the Macintosh computer and consists of a white hand with five fingers. According to Michele White, this prevalent graphic symbol "conceptually recognizes and establishes whiteness and able-bodiedness as the norm" because it is "designed to assert that the white material body is present" everywhere in the computational interface, positioning the imaginary white user as able to click and control every button or feature.[86] Several decades later, white hand pointers continue to be the default, yet they can sometimes be changed by employing Apple's and Windows' "accessibility" system preferences, associating "other color options with disability."[87] This slip between racism and ableism, as we shall see throughout the book, is not anecdotal. As critical disability scholars repeatedly argue, ableism cannot be isolated from other systems of oppression, including sexism, white supremacy, capitalism, and settler colonialism, because they "are categorically and phenomenologically entwined."[88] As a new generation of computer historians

reveals the forgotten contributions to computer science of women, queer, and transgender programmers from various racial and ethnic backgrounds, an intersectional approach is key to illuminating why these groundbreaking ideas were often rejected, ignored, or stolen from their originators.[89] An intersectional critique of the GUI, for example, can draw attention to the ways in which the shift from the black background of the command-line to the allure of Jobs's "wasteful whiteness" was ideological, racist, and ableist, positing both whiteness and vision as the implicit attributes of computer users.[90]

The GUI is also a productive example of how design decisions can exclude some users with disabilities while empowering others. The first commercial GUI, Apple's Lisa, was marketed as an "accessible" interface designed to "lessen the burden of knowledge required to complete a task."[91] In practice, however, it excluded blind users because it was incompatible with screen readers or voice synthesizers. As a result, the new, hard-won "electronic independence" achieved by blind users of early personal computers was put on hold for several years.[92] At the same time, the GUI was celebrated by users with learning disabilities. Users who found it difficult to read or write were suddenly able to navigate a visual system by clicking instead of typing. As described by Mike Matvy, an American psychologist with a learning disability, "it is as if MAC were designed specifically with my needs in mind."[93] Replacing a text-based interface with a clickable one radically changed the way different users interacted with their computers, empowering people with dyslexia while preventing people with low vision or blindness from applying for a wide range of computer-supported jobs.

The accessibility issues created by the point-and-click design of Jobs's GUI were eventually solved by retrofitting and adding new software to make the interface compatible with screen readers.[94] This delay, however, attests to how designers of new technologies neglect to consider a variety of users, forcing them into a waiting or a standby mode until new tools are developed. By the time a technology becomes more accessible, newer technologies flood the market, and disabled users might feel that they are perpetually desynchronized with their normative counterparts. Such delays conjure people with disabilities as slower and therefore occupying a less technologically developed world than able-bodied users.

The ableist notion that the disabled user is the one who might be left behind, rather than speed ahead, ignores the long and rich history of disability hacktivism and "crip technoscience."[95] In their 2020 manifesto, Aimi Hamraie and Kelly Fritsch define crip technoscience as a method and a field of research "acknowledging that many of the technologies that have enabled disabled

people to gain access to the social world have been produced through military-industrial research and development, imperial and colonial relations, and ecological destruction, all of which contribute to the uneven debilitation of human and non-human life."[96] To mitigate these tensions between enhanced accessibility and the destructive logic of what Bill Gates hailed as "friction-less capitalism," crip technoscience calls us to "conjure frictional practices of access production, acknowledging that science and technology can be used to both produce and dismantle injustice."[97] By cripping the interface, I explain how disabled users might speed ahead against expectations *or* create more friction on purpose and slow the system down—depending on the context.

This is not to claim that every mode of media consumption and user interface must be equally accessible to every single user—a goal that is both unattainable and, as John Lee Clark reminds us, not always desirable—but rather to open up the political question of sensory and "access entitlement" and to call media scholars to further study differing habits of decoding.[98] Crip sensitivities also move beyond hand-machine interaction, to highlight a wide range of ways in which people with disabilities might interact with computers, from head and mouth sticks to speech-to-text technologies.[99] Personal computers, game controllers, and other electronic devices use only a small fraction of the human sensorium, a point I will return to in chapter 1.[100]

Able-bodied users, I argue, adapt to the extraordinary demands of an ableist world by engaging in crip spectatorial activities pioneered and made possible by people with disabilities, from speed watching to light calibration tools such as night mode. To that extent, *Interface Frictions* advances a theory of crip interfaces that pushes users to reflect on their dependency on their screens. The case studies I explore, from the experimental video game *Seventy-Eight* to the video art work *CRIP TIME* (2018) and media made by and for bedridden people, bring together narrated accounts of users with disabilities, autoethnography, and critical theory. These experiments in frictional aesthetics provide playful alternatives to the design scripts embedded in refreshing, speed watching, binge-watching, or expecting a computer to lull its user to sleep.

What might happen if we unpack the history of some of the most ubiquitous design features from the point of view of multiple different users, closely accounting for their ever-changing embodied experience? How can users and makers who are blind, deaf, insomniac, depressed, or chronically ill illuminate the multiple embodiments and lived experiences often excluded from design scripts? And how can we account for those features that, despite being marketed as assistive and empowering, are experienced as ableist and debilitating by some users?

Chapter Breakdown

Interface Frictions is structured around four chapters, each of which explores a spectatorial mode and a common friction, from anxiety to fatigue (see table 1.1). Starting with elderly users' failed attempts to refresh vaccine distribution websites during the pandemic, chapter 1 offers a history and theory of refreshing. What kind of media literacy and muscle memory are invoked by this repetitive daily gesture? Moving from the invention of the thumb-based pull-to-refresh feature on mobile phones to auto-refreshing software preventing blind users from effectively using their screen readers, I trace the refresh back to radar technologies and the military-industrial complex. The chapter concludes by surveying alternative design solutions that arise from frictional aesthetics, asking how crip interfaces can enable users to directly engage with the software, rather than desperately refreshing their devices?

If "seamful design" calls designers and users to strategically increase friction, speed watching can be read as its mirror image: a productivity tool described by users as a means of time hacking that can help them become digital "super-users."[101] The recent public debate surrounding Netflix's attempt to add a playback speed feature to its streaming platform, however, stresses the potential frictions between different modalities of media consumption. World-renowned filmmakers pushed Netflix to shelve this idea, claiming their films were not meant to be watched twice as fast as they intended. Yet, citing "requests from our deaf and blind subscribers," Netflix decided in August 2020 to introduce this feature despite the initial backlash from filmmakers. Chapter 2 explores what led to this decision and what the marketing discourse surrounding it can teach us about how corporations monetize accessibility by engaging in "cripwashing." Pushing against the ableist myth of the "super-user," I build on the work of Mills and Sterne to argue that speed watching was anticipated by blind students who hacked their phonographs in order to play early talking books at a faster rate. Speed watching should be read as a mode of survival enabling different users to advance a wide range of goals: media accessibility, the thrill of speed, or avoiding boredom.

Much like playback speed, the autoplay feature radically shifted the way users engage with online content. Embedded into streaming platforms in the early 2010s, it not only popularized binge-watching by automatically playing another title, but also reformatted narrative and aesthetic conventions of serialized content. Chapter 3 explores how the recommendation algorithms and ever-shrinking countdown clocks have reshaped media consumption over the past decade. The chapter offers a historical analysis of autoplay based on tech blogs,

	SPECTATORIAL MODE	DESIGN FEATURE	DOMINANT FRICTION
CHAPTER 1	Buffering	Refresh	Perpetual anxiety + addiction
CHAPTER 2	Speed watching	Playback speed	Eye strain + cognitive overload
CHAPTER 3	Binge-watching	Autoplay	Potential emotional triggers + fatigue
CHAPTER 4	Soporific media	Night Shift	Fatigue + addiction

TABLE I.1 Chapter Breakdown

press coverage, and an interview I conducted with Robert Sweeney, one of the software engineers who created and implemented autoplay for Netflix. Sweeney's account reveals the frequent gap between the stated goals of design features and their unintended consequences. While the autoplay feature was introduced in part to improve A/B testing for Netflix's recommendation system, it quickly became the most successful feature in the company's history, pushing it to change its key performance indicator from "retention" to "hours watched."

One unplanned effect of autoplay, I argue, is the automatization of trauma. This was the result of Netflix's controversial decision to autoplay previews on its home page, reluctantly exposing users to disturbing content that can trigger anxiety and hinder sleep. I draw on Nicolette Little's theorization of "platform violence" to analyze how this default feature proved harmful to subscribers suffering from PTSD, as it confronts them with stories about rapists, serial killers, hate crimes, and domestic abuse.[102] Following numerous complaints and an online petition, Netflix eventually introduced the option to disable autoplay, showing that users can actively reshape interface design. By historicizing autoplay on Netflix and beyond, we can understand how design features are shaped by regulatory, algorithmic, and social forces. How did autoplay become one of the most prominent business models in the digital ecosystem? Why is it crucial for the success of streaming platforms, despite exposing users to potentially harmful content? And how can alternative features and "trauma-informed design" help us reimagine algorithmically shaped media consumption?[103]

Autoplay works in tandem with Apple's Night Shift and other tools designed to filter blue light from screens after sunset to encourage users to take their personal electronics to bed. Studying the soporific media industry, chapter 4 begins by contrasting Apple's claims that its Night Shift feature "may help you get a better night's sleep" with the recent literature on "sleep hygiene." Night Shift, as well as various similar features marketed by Apple's competitors, is part of an emerging ecosystem of sleep-supporting media, which includes a plethora of design features, sleep apps, and sleep trackers. Night Shift and the popular sleep app Calm, I argue, privileges a subject who cannot disconnect from their technology. Rejecting this techno-solutionism, this chapter offers a theory of digitally induced exhaustion.

Focusing on Calm's popular "sleep stories," I argue that sleep apps are content-agnostic because their promise lies in the postural transitions they produce, rather than in their ever-expanding media libraries. By inviting their users to switch from sedentary engagement with their devices to lying down, these postural media create a sense of intimacy, safety, and attachment. At the same time, these subscription-based apps individualize the problem of sleep by denying the inherent nature of digital lethargy. What I call *crip horizontal media*, on the other hand, offers an alternative to the tech-based model of sleep-inducing apps and devices. By studying three crip interventions made by bedridden artists—a painting by Frida Kahlo, a video essay by Hannah Bullock, and a collection of pandemic shorts by Dayna McLeod—I explore sleep as part of a collective and communal ethics of care.

The four design features and spectatorial modes explored in *Interface Frictions* introduce an interdisciplinary theory of the digital interface and its somatic temporalities of waiting, compression, endurance, and drowsiness. As different as these states seem to be, they all produce and sustain an unrecognized friction between the interface and its real-life user. Due to the growing ubiquity of remote work and video-conferencing platforms, we are now accustomed to watching each other through plastic and glass screens. Zoom and other video-conferencing platforms, which I explore in the conclusion, can be read both as crippling interfaces—turning the home into an office, promoting a sedentary lifestyle, deepening the digital divide—and as crip interfaces allowing people with disabilities to engage with the world in unprecedented ways. It is those nuances and contradictions that populate every page of this book.

NOTES

INTRODUCTION: DISABLED/ENABLED

Epigraph 1. Mills and Sterne, "Dismediation," 368.
Epigraph 2. Jain, "Prosthetic Imagination," 33.

1. In the United States, rural towns suffered from lack of broadband that, amid the spread of COVID, limited people's ability to remain informed. Even tech workers in urban centers experienced more buffering during the early months of the pandemic: "As people have hunkered down to contain the spread of the coronavirus, average internet speeds all over the world have slowed. Some broadband providers are feeling crushed by the heavy traffic. And dated internet equipment can create a bottleneck for our speeds." See Chen, "Everything You Need to Know."
2. For a historical analysis of the rise of computer-inflicted pain and injuries since the 1980s, see Nooney, "Have Any Remedies," 416–34.
3. I borrow the term "disabled cyborg" from Laura Forlano. See Forlano, "Crip Futurity."
4. For a complete list of ReelAbilities' accommodations, see https://reelabilities.org/newyork/accessibility/.
5. See Nooney, "Have Any Remedies," 417.
6. Costanza-Chock, *Design Justice*, 47. For a critique and historical overview of the idea of the "average user" as a white, able-bodied user, see also Mulvin, *Proxies*.
7. The term "techno-chauvinism" was coined by Meredith Broussard to describe gender inequality in the tech industry and how it produces gender-based algorithmic biases. See Broussard, *Artificial Unintelligence*.
8. I here draw on Jain's critique of the assumption of a "normative" tech user in media theory. See Jain, "Prosthetic Imagination," 33.
9. For a historical analysis of internet-based access, see Ellcessor, *Restricted Access*.
10. Mills and Sterne, "Dismediation," 372.
11. Mills and Sterne, "Dismediation," 368.
12. For an overview and critique of these models of disability, see, for example, Ben-Moshe et al., "Disability Politics," 178–93.

13. See Ben-Moshe et al., "Disability Politics," 178.
14. For a critique of the curb cut as the model and the most prevalent metaphor for disability accommodation, see Hamraie, *Building Access*, 125–30.
15. Tracing biometric technologies to the branding of African slaves by their white owners in order to identify, control, and deter them from running away, Simone Browne studies the rise of digital and algorithmic-based biometrics as part of a longer legacy of racialized state violence. She suggests the concepts of "digital epidermalization" and "prototypical whiteness" to consider "what happens when certain bodies are rendered as digitized code." See Browne, *Dark Matters*, 109–16.
16. See Kafer, *Feminist, Queer, Crip*, 4–10.
17. Kafer, *Feminist, Queer, Crip*, 7.
18. See Browne, *Dark Matters*, 122–26.
19. In their critique of the social model and the "disability rights" framework that focuses on legislative protections from discrimination, for example, A. J. Withers and Liat Ben-Moshe contend that "rights frameworks in general can be described as assimilationist rather than radical (radical in the sense of transforming the root causes of oppression)." See Ben-Moshe et al., "Disability Politics," 179.
20. For an overview of the emerging field of "critical access studies," see Hamraie, *Building Access*, 13.
21. See, for example, Piepzna-Samarasinha and Lakshimi, *Care Work*.
22. The term "security theater" was coined by computer security specialist and writer Bruce Schneier for his book *Beyond Fear* (2003), but has gained currency in security circles, particularly for describing airport security measures. See Schneier, *Beyond Fear*.
23. For an analysis of the racism and sexism of face recognition technologies, see Magnet, *When Biometrics Fail*.
24. See Ellcessor, *Restricted Access*.
25. Ellcessor, *Restricted Access*, 11.
26. I borrow the term "ideal user position" from Elccessor. See Ellcessor, *Restricted Access*, 71–74.
27. For an overview of spoon theory and "spoonies," see Miserandino, "Spoon Theory."
28. Nooney, "Have Any Remedies," 416.
29. For an analysis of the "broken body" of computer programmers, see White, *Body and the Screen*, 177–97.
30. Livingston, *Debility and the Moral Imagination*, 234.
31. Puar, *Right to Maim*, xvi.
32. Puar, *Right to Maim*, xiii.
33. Basel Action Network and Silicon Valley Toxics Coalition, *Exporting Harm*, 31.
34. Basel Action Network and Silicon Valley Toxics Coalition, *Exporting Harm*, 31.
35. For an overview of the labor conditions in Amazon warehouses, see Hu, *Digital Lethargy*, 8–14.
36. Hamraie, "Universal Design," 1–22.
37. Hamraie, "Universal Design," 4.
38. Jain, "Inscription Fantasies and Interface Erotics," 219.

39. Nooney, "Personal Computer," emphasis added.
40. Screen time rocketed during the pandemic. One study showed the percentage of kids spending more than four hours daily on their devices nearly doubled, while another found the average screen time for teenagers went from 3.8 hours before the pandemic to 7.7 hours during the early months of lockdowns. See Berthold, "Adolescents' Recreational Screen Time"; see also Bernstein, "Window of Opportunity," 64–83.
41. For an overview of the growing overuse of technology and the inability to opt out, see Bernstein, *Unwired*.
42. Sterne, *Diminished Faculties*, 123.
43. Sterne, *Diminished Faculties*, 123.
44. Sterne, *Diminished Faculties*, 123.
45. For an overview of these trends, and especially the "slow computing" movement, see Kitchin and Fraser, *Slow Computing*.
46. Jain, "Inscription Fantasies and Interface Erotics," 220.
47. Jain, "Inscription Fantasies and Interface Erotics," 224.
48. Jain, "Inscription Fantasies and Interface Erotics," 224.
49. Jain, "Inscription Fantasies and Interface Erotics," 221.
50. Uncovering the century-long history of this sexist tendency, Jain writes, "Between 1950 and 1980 carpal tunnel syndrome remained unrecognized under worker's compensation in the U.S.; it was understood to be a disease of middle-aged women attributable to hormonal changes." In short, even when machine-induced pain has been common enough to be addressed, it was attributed to the female body—protecting designers and manufactures from having to compensate employees in case of injury. See Jain, "Inscription Fantasies and Interface Erotics," 245.
51. Jain, "Inscription Fantasies and Interface Erotics," 242.
52. For a discussion of how people with disabilities have employed remote access tools during the pandemic, see the conclusion. See also Mills et al., *How to Be Disabled in a Pandemic*.
53. As Natasha Dow Schüll suggests, time-on-device is the raison d'être of casinos: The more time gamblers spend on any given slot machine, the more money they are likely to waste. See Schüll, *Addiction by Design*; For a survey of addictive design methods from a legal perspective, see Bernstein, "Window of Opportunity," 64–83.
54. I will return to the idea of captology in chapter 3. See also Seaver, "Captivating Algorithms," 421–36.
55. Schüll, *Addiction by Design*, 12.
56. Schüll, *Addiction by Design*, 13.
57. Schüll, *Addiction by Design*, 16.
58. Schüll, *Addiction by Design*, 16.
59. Schüll, *Addiction by Design*, 21.
60. Hartogsohn and Vudka, "Technology and Addiction," 1–11.
61. Hartogsohn and Vudka, "Technology and Addiction," 4.
62. Hartogsohn and Vudka, "Technology and Addiction," 4.

63. For a survey of such treatment programs, see Hartogsohn and Vudka, "Technology and Addiction," 5.
64. Hartogsohn and Vudka, "Technology and Addiction," 4.
65. Hartogsohn and Vudka, "Technology and Addiction," 6.
66. Murthy, "Surgeon General."
67. Murthy, "Surgeon General."
68. In 2017, Netflix's founder, Reed Hastings, famously stated that the company's most fierce competitor is sleep: "You get a show or a movie you're really dying to watch, and you end up staying up late at night, so we actually compete with sleep—and we're winning!" See Raphael, "Netflix CEO."
69. Hu, *Digital Lethargy*.
70. Hu, *Digital Lethargy*, 38.
71. For a discussion of "prototypical whiteness," see Browne, *Dark Matters*, 26–27.
72. See, for example, O'Neil, *Weapons of Math Destruction*; see also Eubanks, *Automating Inequality*.
73. The reclaiming of "crip" is attributed to Carrie Sandahl's influential 2003 essay and to Robert McRuer's *Crip Theory* (2006). See Sandahl, QUEERING THE CRIP, 25–56; McRuer, *Crip Theory*.
74. See Lewis, "Crip," 47.
75. Disability scholar Eli Clare, for example, employs "bodymind" as a way to resist common Western assumptions that the body and mind are separate entities, or that the mind is "superior" to the body. See Clare, *Brilliant Imperfection*; see also Lewis, "Crip," 47.
76. Margaret Price, who introduced the term "bodymind" into disability studies, writes that it acknowledges that "mental and physical processes not only affect each other but also give rise to each other—that is, because they tend to act as one, even though they are conventionally understood as two." See Price, "Bodymind Problem," 268–84. For a critique of the health-sickness binary, see Metzl and Kirkland, eds., *Against Health*.
77. For an overview of 1990s techno-utopias of the Internet as a space of empowerment for people with disabilities, see Ellcessor, *Restricted Access*, 78–80.
78. Ellcessor, *Restricted Access*, 74.
79. Galloway, *Interface Effect*, 31.
80. Galloway, *Interface Effect*, 64.
81. For a critique of McLuhan's universalized media consumer, see Sharma and Singh, eds. *Re-Understanding Media*.
82. Critiquing the frequent use of terms like "prosthesis" and "amputation" in media discourse, Elizabeth Petrick warns, "When a marginalized group is treated as merely a metaphor, they become further erased from the history they were a part of." See Petrick, "Computer as Prosthesis?," 401.
83. The artist and writer American Artist theorizes this shift as a denial of Blackness due to its reliance on white-imbued interface design and its emphasis on productivity. See Artist, "Black Gooey Universe," 42.
84. Norman, *Invisible Computer*.

85. See Arnall, "No to No UI."
86. White, *Touch Screen Theory*, 11.
87. White, *Touch Screen Theory*, 14.
88. For an overview of intersectional approaches to disability studies, see Smilges, *Crip Negativity*.
89. Works that offer alternative, queer, and feminist histories of computation include, for example, Pow, "Trans Historiography of Glitches," 197–230; Hicks, "Hacking the Cis-tem," 20–33; Dame-Griff, *Two Revolutions*; and Nooney, "Uncredited," 119–46.
90. Artist, "Black Gooey Universe," 42.
91. Artist, "Black Gooey Universe."
92. Joe Lazzaro, qtd. in Ellcessor, *Restricted Access*, 96.
93. Petrick, "Computer as Prosthesis?," 408.
94. Ellcessor, *Restricted Access*, 96.
95. Hamraie and Fritsch, "Crip Technoscience Manifesto." For a history of disability hacktivism see also Goggin, "Disability and Haptic Mobile Media," 1563–1580.
96. Hamraie and Fritsch, "Crip Technoscience Manifesto."
97. Hamraie and Fritsch, "Crip Technoscience Manifesto."
98. Lucas Hilderbrand uses the term "access entitlement" to connote the rising expectation that video and audio content will be available on demand. See Hilderbrand, *Inherent Vice*, 10. For a disability-informed critique of access as necessarily desired and empowering, see Clark, "Against Access."
99. Goggin, "Disability and Haptic Mobile Media," 1569.
100. Parisi, "Fingerbombing," 323.
101. I will return to the idea of the super-user in chapter 2. See Rezab, "Why I Watch Videos."
102. Little, "Social Media 'Ghosts,'" 1–30.
103. For an exploration of trauma-informed design, see Little, "Social Media 'Ghosts.'"

CHAPTER 1. REPETITION, RELOADED

Epigraph 1. Bill Gates, quoted in Chun, *Updating to Remain the Same*, 71.
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1. See, for example, *NBC Boston*, "Massachusetts Vaccination Scheduling Website Crashes."
2. Chen, "Rage Quit."
3. See Applebaum, "Frustration Is Spreading Faster."
4. Dai, "US Government's $44 Million Vaccine."
5. As reported on the local news website *WBUR*, "Olivia Adams, a software developer who created MACovidVaccines.com while on maternity leave, uses one such service from Amazon. That's why her website didn't crash when the state's did, she thinks." See Chen, "Rage Quit."