Promissory Failures: How Consumer Health Technologies Build Value, Infrastructures, and the Future in the Present

by

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I dedicate this dissertation to my mother, Rozana Rab Alam, my grandmother, Zobeida Rab, and my dear friend, Lisa Malchow, who have been and continue to be an inspiration to me.
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ABSTRACT  

In 2007, Apple, Inc. released its first smartphone, the iPhone, which included a built-in accelerometer that continuously collected data on user movements. However, users were not invited to engage with data amassed by the accelerometer until 2014, when the company released “iOS Health,” now a standard feature of their devices that allows users to track their movement and other health metrics. What changed? In this dissertation, I situate this shift within the context, rise, and promises of consumer health technologies. I explore the social, economic, and technical conditions through which consumer health technologies become possible, valuable, and desirable, such that they proliferate.

Drawing on interviews with venture capitalists, angel investors, and founders and employees of digital health and wellness companies, as well as ethnographic observations of digital health and technology events in the San Francisco Bay Area, I trace the kinds of capital, ideologies, subjects, and infrastructures that both constitute and are constituted by these technologies and their futures. I first explore the consumer electronic infrastructure and financing strategies that I argue together make consumer health technologies possible and contend that speculation around future value is built into how capital is advanced in the present, which critically shapes these technologies’ trajectories. I then argue that, despite the failures and limitations of consumer health technologies, investors and founders consider these devices to be valuable because they assemble the infrastructure for a future by stabilizing ideas about how health should be known, collected, measured, practiced, and valued in ways that are increasingly hard to see. Lastly, I argue that consumer health technologies proliferate in part because
consumers are being enrolled into the lifestyles and subjectivities through which these technologies make sense and feel self-evident. I contend that this enrollment creates a social infrastructure that secures value in future by inculcating subjects into the logics of a tracked life in the present. Overall, this dissertation reveals how assembling subjects and standardizing data streams circulates promissory value by laying the groundwork for a passively tracked future that assembles and secures life as an asset in the present.
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CHAPTER 1: INTRODUCTION

In 2007, consumer electronics company Apple, Inc. released its first smartphone, called the iPhone, which was equipped with three sensors: an accelerometer, ambient light sensor, and proximity sensor. However, users were not invited to engage with data amassed by the accelerometer until 2014, when the company released “iOS Health,” a pre-installed mobile application (app) that provides users with a “dashboard” to view their movement and, when paired with third-party technologies, other health metrics such as sleep patterns and heart rate. While users can disable the dashboard view, they cannot delete the app or disable movement tracking. The Health app uses the same technology that essentially had been an invisible part of the iPhone since 2007. What changed?

To understand this, it is necessary to situate Apple’s Health app within the context and proliferation of consumer health and wellness technologies in the U.S. These technologies describe a range of digital tools advertised to help consumers manage their health and wellness. They include so-called “wearables,” or devices typically worn directly on the body (e.g., on the wrist or neck) or clipped to clothing. Wearables come in a wide variety of forms but usually house a complex network of sensors that can track a consumer’s movement, location, heart rate, sleep patterns, skin temperature, sweat composition, breathing patterns, and other states and behaviors. Most wearables include a companion mobile app that consumers can install on their smartphones or use on a web browser, that serves as a computing interface for the device. There are a wide variety of standalone mobile health apps as well, some of which allow consumers to keep track of their health records or connect to healthcare providers, while others encourage consumers to manually track or allow mobile phone sensors to measure food consumption, movement activity levels, and emotional states.
All of these technologies are *consumer* health and wellness technologies because they are sold directly to consumers\(^4\) and access to them is not necessarily mediated by a health care provider, hospital system, or insurance company. Because these technologies are sold on the consumer market, large consumer technology companies—like Google and Apple—as well as small startups outside of the healthcare sector, are now in the business of generating data to define, measure, and represent health and wellness. These technologies are also designed to integrate seamlessly with consumer life by syncing with devices that consumers already use regularly, such as a smartphone. These devices are interactive, unlike medical devices such as a pacemaker, and other consumer wellness products like a treadmill. Apps and devices often collect data continuously, thereby encouraging consumers to check in regularly, get feedback on their behaviors, and sometimes manually enter data, such as calories consumed. Additionally, these technologies are designed to look and feel like other consumer toys, equipped with games and social networking features. Wearables in particular are also seen as part of larger trend towards an increasingly networked environment, known as the internet of things (IoT, described in Chapter 3), wherein objects in consumer environments, from vehicles to home appliances, can communicate wirelessly with each other without the user’s direct intervention. As these devices proliferate, measuring and defining health is moving into consumer objects and spaces, like consumers’ homes, phones, and vehicles, and in turn, pervading consumer life.

These technologies have become increasingly widespread in the U.S. and are now a multibillion-dollar industry. Fitbit, Inc. began as a small startup in San Francisco in 2007 and is now the U.S.’s leading wearable vendor, and has sold over 20 million\(^5\) wearable activity trackers. In 2015, Fitbit held an initial public offering, thereby becoming a publicly traded company, and was valued at over $5 billion. The company’s market capitalization is now\(^6\) $2.89 billion, and
reported $1.86 billion in revenue in 2015. Large consumer electronic and technology companies, such as Apple, Inc., and Google, Inc., have entered the market as well, selling sensor-equipped smartwatches. Apple is the market leader and has sold an estimated 12 million smartwatches as of 2016, earning an estimated $6 billion in revenue in just two years (Wakabayashi 2016). Consulting firm Accenture (2016:7) estimates that in 2016, 21% of U.S. consumers use wearables (up from 9% in 2014) and 33% use health apps (up from 16% in 2014). In addition, there are now more than 100,000 health and wellness apps for these devices with an estimated 3 billion downloads globally in 2015, most of which run on Apple and Google operating systems. Many of these technologies, particularly activity trackers and smartwatches, generate billions of dollars of revenue every year.

I contend that these technologies proliferate, despite failures and limitations, in part because the founders and investors who develop them imagine value in the futures these technologies make possible. By arguing that these technologies are the critical first step in constructing the infrastructure of those futures, I complicate how value is constructed in these technologies and its implications. These technologies are financed by a specific form of capital, known as equity finance, that fundamentally shapes their trajectories and therefore forms the critical context in and through which these devices proliferate. In this dissertation, I am centrally concerned with how and why founders and investors consider consumer health and wellness—and technologically-mediated understandings and experiences of health and wellness—to be valuable. Conventional answers to questions of value in consumer health and wellness technology focus on the sale of products and/or exchange of data as central sources of value and, eventually, profit. I argue that from the perspective of founders and investors, these tools are
valuable for the social and economic groundwork they lay to make an increasingly tracked future possible.

However, most startups, including health technology startups, will fail financially, and profit is not only deferred, but often never achieved. Existing critical scholarship on digital health, such as Lupton (2014a, 2016, n.d.), Crawford and colleagues (2015), and Schüll (2016), fail to see and cannot even account for this incredible pervasiveness of failure in the technology sector. Unlike other commentators, I contend that how equity financing is structured and rationalized fundamentally shapes the development of consumer health technologies and the social, cultural, and economic work that they are imagined to perform. By centering questions of (future, potential) value and equity financing, I consider how value is imagined in technologies in the absence of profit and in the midst of failure. I argue that founders and investors construct value in the world and futures that these technologies make imaginable and the social, technical, and economic work that they do to make that future possible. Thus, value is not only imagined through profit and data but in potential and futures.

In this dissertation, I argue that consumer health and wellness technologies are understood to be valuable in spite of their failures because of the futures they set in motion in the present. I argue that investors and founders see value in how these technologies create the possibility of an increasingly tracked life by establishing a portal into all aspects of consumer life and by assembling consenting subjects in the present by normalizing and rendering self-evident the incredible surveillance these technologies effect. By assembling the infrastructure through which continuously tracked life becomes possible and desirable, these technologies effect an assetization of life by creating the potential for companies to generate capital from life
indefinitely into the future. Thus, I contend that the infrastructures these devices lay in the present are designed to secure future value.

THEORETICAL FRAMEWORKS

This dissertation draws on several theoretical frameworks to make sense of the social construction of value in consumer health and wellness technologies. I approach these frameworks as sensitizing concepts, which Blumer (1954:7) argues provides analysts with “directions along which to look” when analyzing data. I draw on critical approaches to digital health technologies, theories of infrastructure, biomedicalization theory, and theories of capital to understand and situate the work that consumer health and wellness technologies perform. I put these various sensitizing concepts in conversation to consider how the proliferation of these technologies assembles an infrastructure that works to secure future value by financializing life itself—that is, by leverages financial practices of speculation, derivation, and investment to produce life as a stream of continuous capital accumulation. Taken together, these frameworks allow me account for myriad forms of value that go beyond the exchange of data that Lupton (2014a, 2016, n.d.), for example, sees as necessarily circulating value and profit; rather, integrating these frameworks allows me to foreground how value is understood to inhere in the futures these technologies set in motion through the infrastructural work that is already underway.

Critical Approaches to Big Data & Digital Health Technologies

Social scientists have begun to examine the emergence and proliferation of consumer health and wellness technologies and Big Data analytics. This scholarship variously foregrounds the implications of these technologies, including the potential for new forms of governance and
surveillance as well as new subjectivities. Some of these scholars (e.g., Lupton 2014a; 2016; n.d.) and Till (2014) raise critical questions about new forms of capital and exploitation that these technologies make possible. While this literature opens up questions about the forms of governance and capital flows that these technologies effect, this literature fails to consider how these technologies engender consent to the lifestyles and surveillance entailed in these technologies. In addition, though they consider questions of value in these devices, they take the data generated by these devices as the starting point for value, rather than also considering how claims of value help finance the companies that develop these technologies in the first place. I argue that capital, particularly equity finance, flows from promises these companies make to investors about the future. By centering the social construction of value in these devices, I attend to different processes, actors, and practices than these scholars, and reveal the critical infrastructures through which these forms of governance (and consent) and data capitalization are effected.

Sociologist Deborah Lupton has written widely about these technologies. Drawing on marketing materials for apps and devices, Lupton (2014b; 2014c; 2014a; 2016; n.d.) and Lupton and Jutel (2015) explicitly explore the social, cultural, economic, and political implications of these technologies. I draw on Lupton’s scholarship to consider the subjects entailed in these devices and the forms of governance and discipline they effect. Lupton claims that these disciplining technologies encourage and effect self-surveillance, which she argues further entrenches the neoliberal moral imperative for patients to assume responsibility for their health and wellness (2014a; 2014c; 2016; n.d.). She argues that these technologies are becoming integrated into practices of selfhood, as the data they generate become self-knowledge that encourage users to take on the responsibility for engineering better life (Lupton 2014c; n.d.).
These fetishized, valorized, and neutralized data are constructed as facts about the body that already existed but are now legible and accessible to the consumer. Drawing on Foucault, Lupton variously argues that these technologies are disciplinary tools that function to govern the self through intense self-surveillance, self-monitoring, and what she calls “dataveillance,” where surveillance is effected and digitized through peoples’ continuous use of technologies (Lupton 2014a; 2016). Similarly, Crawford and colleagues (2015) contend that the way these data travel may be effecting a new kind of surveillance on and capitalization of consumer bodies, thus arguing “while self-knowledge may be the rhetoric of wearable device advertising, it is just as much a technology of being known by others” (Crawford et al. 2015:493-494). Drawing on Foucault (1991), they suggest that these technologies effect normalization and individuation. These forms of governance are constructed as a voluntary choice “as part of the quest for self-optimisation and as an often pleasurable and playful mode of self-surveillance” (Lupton 2014c:3). Finally, Lupton (2016) argues that data assemblages being formed from continuous self-tracking are a form of biocapital because they derive value from and circulate life (Sunder Rajan 2006) as well as further the “digital data economy” that “positions digital data objects as valuable” (Lupton 2016:116). Consumer data are increasingly monetized, exchanged, and generate capital, exploiting consumer data for private gain. However, by focusing solely on how value is derived from the data these companies generate and exchange, Lupton misses how other forms of value are imagined in these devices and their implications.

In this dissertation, I also explore the kinds of work subjects are required to do as they are disciplined and governed by these devices. Till (2014) provides a way to theorize the labor activity that users perform and from which value is extracted for private gain. She explores self-tracking behavior as digital labor and examines the “macro-level tactics” of the corporations that
generate these data and generate value therein. Focusing specifically on activity monitors, such as those manufactured by Fitbit, Till (2014:458) argues that these tools commodify exercise activity, where the exercise itself “is being turned into a form that is amenable to the extraction of value,” thereby creating a form of surplus value out of consumer leisure activity. Moreover, as these technologies are increasingly integrated into workplace wellness programs and employee benefit structures (through health insurance premium discounts), she argues that attention should be paid to the relationships among labor, health, and self-tracking devices and the coercive nature of these policies.

While Lupton (2014a), Lupton and Jutel (2015), and Crawford and colleagues (2015) rely on marketing, advertising, and other promotional materials for much of their research on these technologies, Schüll (2016) takes a different approach. She instead peers “‘behind’ the finished products” to explore how the designers and developers of consumer health and wellness devices construct and imagine their technologies. Drawing on Dumit (2012) and others’ work about the extension and encroachment of health risk, and therefore biomedical technologies, into all phases of life, Schüll (2016) argues that these technologies and their focus on prevention and life optimization create data for life. Similar to Lupton (2013a) and Crawford and colleagues (2015), she contends that these data are constructed as capable of rendering the body legible in a way that was not previously possible because these data are collected and feedback is provided continuously.

Because I am centrally concerned with the subjects produced by and required for these technologies and the lifestyles they entail, I leverage Schüll’s (2016:8) research to consider how assumptions about the subject—about the people who need data for life—are embedded and “drafted” into the logics of these devices the design of these technologies. She disagrees with
Lupton’s (2014a; 2016; n.d.) claim that these devices rely on and perpetuate the neoliberal subject who willingly takes on the responsibility of their own health and welfare, which I also claim in Chapter 4. Similar to my findings, Schüll argues that the subject imagined by those who develop these devices is one that needs to be nudged (see Chapter 4) to better health and better life. Schüll (2016) also argues that these subjects diverge from Rose’s (2007) notion that contemporary biopower operates through increasingly autonomous and responsible health consumers whose identity resides in part in their biology (what he calls molecularization). Rather, Schüll (2016:12) argues that these technologies operate at the “informatic-behavioral” level, rather than the genetic or molecular level, and attempt to intervene on consumer conduct, not on their biology through nudging. Schüll (2016:12) argues that the nudgeable subject is “somewhere between enterprise and submission, responsibility and discipline” and possibly “constituted by these tensions.” According to Schüll (2016:12), for the nudgeable subject, “calculation is given over to big-data analytics while self-steering is supplemented by the data-driven nudge.” Her work thus pulls focus towards how governance is effected and subjectivities organized at the behavioral level, rather than the molecular level and foregrounds the critical role of behavioral interventions in the promise of these devices. However, Schüll (2016) fails to explore how data for life is an economic project and promise—a vision for how to build the future that developers use to build value in their products in the present.

Other commentators have explored the processes and effects of the collection, integration, and valuation of Big Data. These scholars, such as van Dijck (2014), Dalton and Thatcher (2015), Kitchin and Lauriault (n.d.), and Degli Esposti (2014) focus particular attention on the types of surveillance that new social media and continuously-connected technologies effect and require, known as dataveillance (Clarke 1988). Technologies like consumer health
devices are making a datafied life possible and, as van Dijck (2014:198) argues, are crucially normalizing “datafication as a new paradigm for science and society,” where consent to datafication becomes the “currency” citizens pay for access to communication (and now health) services. Drawing on Clarke’s (1988) original formulation, these scholars advance the concept of dataveillance because they see it as a unique form of surveillance. As van Dijck (2014:205) explains, “whereas surveillance presumes monitoring for specific purposes, dataveillance entails the continuous tracking of (meta)data for unstated preset purposes. Therefore, dataveillance goes well beyond the proposition of scrutinizing individuals as it penetrates every fiber of the social fabric.” Degli Esposti (2014) explicates how this type of surveillance is a form of governance that increasingly claims and seeks to alter peoples’ future behavior through datafied interventions. She examines Big Data as socio-technical systems that are embedded in social relations and are designed to manipulate human behavior for private gain.

Other commentators, such as Kitchin and Lauriault (n.d.) and Dalton and Thatcher (2015) argue for a field of critical data studies to interrogate the conditions that have led to Big Data and dataveillance; the assemblages through which Big Data and Big Data technologies are produced and propagated; and the effects of these technologies on knowledge, subjects, and society. They argue that further research is needed to understand the social construction and stakes of these technologies. Degli Esposti (2014) specifically calls for future research to consider the standardization of dataveillance and the subjects assumed in and required for dataveillance technologies to take hold among consumers.

These scholars raise crucial questions about how dataveillance technologies effect a form of governance and advance a logic of and consent to what van Dijck (2014) calls dataism, wherein data are considered neutral, raw, and objective, which spurs their collection and
entrenchment as governing technologies. Following their calls for further research, this dissertation explicitly explores the social, technical, economic conditions that are critical to the production, promises, and propagation of these technologies. Moreover, following Degli Esposti (2014), I pay careful attention to the kinds of consent and subjectivities that are critical to the standardization and institutionalization of dataveillance. However, while some of these scholars (e.g., Esposti 2014; Kitchin and Lauriault n.d.; van Dijck 2014) attend to or raise questions about the economic value of these data, they fail to consider the critical role that financial logics play in the possibility of dataveillance. I situate the technologies that effect this form of surveillance within the structure and promissory nature of equity financing to better understand how these technologies are understood to be valuable and the kinds of work they are imagined to perform. Moreover, I integrate questions of consent and standardization to complicate how the normalization of dataification is made possible through the strategic assembly of social, economic, and digital infrastructures.

This emerging literature on both dataveillance and digital health raises crucial questions about the logics and discourses through which consumer health technologies are produced and the potential implications of these devices for the surveillance, circulation and capitalization of consumer life. However, unlike many of the digital health commentators, this dissertation explores these questions by explicitly centering the perspectives of the founders and *investors* actively involved in the design, development, valuation, and financing of these devices rather than relying on marketing materials alone, which Lupton (2014a) explicitly calls for. In theorizing the effects of these devices as capital-generating technologies, some of these scholars make assumptions about how consumer health technologies and Big Data in general are imagined to be valuable. Lupton (n.d.:13), for example, argues that the self-tracking data that
these technologies generate effect “a new form of commercial value” and exploitation in service of “financial profit.” Van Dijck (2014) similarly limits questions of Big Data’s value their monetization and exchange, thereby foreclosing questions about non-monetary value. These claims neglect the logics and structure of equity financing and the role of equity investors in the construction of value in these technologies, which I show extends beyond “commercial value” and is constructed in the absence of profit. I argue that how these technologies are imagined to be valuable and the ways they circulate life itself in service of this value are empirical questions that are critical to theorizing how these technologies are designed and their imagined trajectories. By explicitly engaging financiers and placing constructions of value at the center of this research, I complicate how value is constructed in these technologies and the implications of these forms of value on their development and effects.

Theories of Infrastructure

Multiple commentators in science and technology studies (STS) have elaborated theories of infrastructure and this dissertation is strongly informed by these approaches. This literature foregrounds how infrastructures are sociopolitical systems that both embed and are embedded in social relations and can stabilize and standardize practices. Some of these scholars emphasize the subjectifying work of infrastructures and others explore how infrastructures enable capital circulations. Following Star and Ruhleder’s (1994:253) provocation that infrastructure is a relation rather than a thing and that we should ask when rather than what is infrastructure, I draw on this literature to consider how consumer health technologies assemble an infrastructure by organizing and standardizing practices and capital circulations. However, unlike these scholars, I integrate theories of capital (described below) with theories of infrastructure to also ask not only how infrastructure enables particular capital flows, but also how infrastructures themselves
produce, support, and maintain multiple *capitalisms*. Using the empirical example of consumer health technologies, I illustrate how infrastructures facilitate capital circulations and *capital extractions*, creating (or promising) new capital opportunities. In this dissertation, I unearth the infrastructural work of these technologies to explicate not only the values (and relations) embedded within these infrastructures, but also how continuous and *future* value is imagined and *secured* through the assembly of these infrastructures.

Scholars like Star and Ruhleder (1994; 1996) highlight not just the material conduits and substrates on which things run, but also the relational, practiced, and symbolic aspects through which infrastructure works and encodes social relations. For example, Bowker and colleagues (2010:99) argue that infrastructure “emerges for people in practice, connected to activities and structures.” Larkin (2013:328) claims that infrastructures are networks that allow “goods, people, or ideas” to flow, thereby contending that infrastructure is “the architecture for circulation.” Critically, this makes infrastructure difficult to see because, when it works, it becomes seamlessly integrated into the practices it organizes and can therefore be easily taken for granted (Bowker and Star 1999; Star 1999; Star and Ruhleder 1996). Drawing on these scholars, I consider how the infrastructures of consumer health technologies are strategically visible to investors and founders as value opportunities but are also designed to be sunk into consumer’s quotidian practices such that consumers are not even aware of their presence. Indeed, Wilson (2016) reminds us that the prefix *infra* denotes “below,” suggesting that infrastructures are those structures and structuring systems that are hidden from view. As these systems get installed behind the scenes, they can become ubiquitous and durable, creating dependency that only reinforces their ubiquity (Plantin et al. 2016). Moreover, infrastructure can operate through standards, and can drive standardization (Dourish and Bell 2007). Star (1999) argues that
infrastructures embody standards and can become invisible through standardization, which can stabilize infrastructure and its politics. Following these scholars, I consider how consumer health and wellness technologies are assembling infrastructure that makes a particular kind of future possible in the background, behind the scenes.

In this dissertation, I argue that consumer health technologies assemble infrastructures in order to secure investor and founders’ interests for the future. I draw on STS scholarship on the sociality of infrastructure, such as Edwards (2003), to consider how politics, values, and interests are built into infrastructure. Edwards (2003:90) argues that infrastructures can “create both opportunities and limits; they promote some interests at the expense of others. To live within the multiple, interlocking infrastructures of modern societies is to know one’s place in gigantic systems which both enable and constrain us.” As such, infrastructures are sociopolitical systems that are both embedded in and themselves embed ideology (Dourish and Bell 2007; Wilson 2016). In Wilson’s (2016) theorization, infrastructure functions as ideology because its hidden nature, routinization, and standardization masks the labor and politics that are critical to their assembly and functioning. Infrastructure’s invisibility can thus be intentional, where such systems are purposely assembled “behind the scenes…in order to achieve the status of taken-for-granted” (Wilson 2016:270). However, the ideological nature of infrastructure can be made visible when infrastructures are being installed and established, “when not yet absorbed into the background” (Wilson 2016:270). Once backgrounded, infrastructures’ ideology can be much harder to see.

Many of these scholars argue that the goal of infrastructure studies is to unearth these sometimes hidden infrastructures, and the values and ideologies that can inhere in them. Bowker and colleagues (2010:105) argue that infrastructure studies can explore how new technologies
may enable (and be shaped by) new forms of sociality and community, the politics that are built into infrastructures, and how new technologies may be changing what they call “knowledge work.” They thus call for infrastructure studies to examine these social and ontological dimensions of infrastructure and their effects. According to Bowker and Star (1999), to explicate infrastructures and how they both organize and are organized by social relations requires *infrastructural inversion*, which recognizes and seeks out the interrelationships among knowledge, politics, standardizations, networks, and technologies. Bowker and colleagues (2010:113) encourage those studying information infrastructure to “move beyond seeing the social, organizational, and cognitive sitting somehow on top of or beside the wires and gateways of the physical infrastructure. Each layer is riven through with each of these dimensions.”

Infrastructure operates and is made operational at all of these levels and therefore requires examination of all of these dimensions. Following Wilson (2016) and Bowker and Star (1999), I attempt to elucidate the infrastructural work, subjects, standards, and consent that consumer health technology companies and investors are *in the process* of assembling as they experiment on their visions of the future.

I also approach the assembly, maintenance, and work of infrastructure as economic projects and draw on Tonkiss (2015), Plantin et al. (2016), and Wilson (2016) to consider how political economy structures and is structured by infrastructure. Tonkiss (2015) pulls focus towards the political economic facets of infrastructure, arguing that infrastructures are economic technologies that not only require capital to be built and to operate, but also distribute wealth and resources unevenly across populations. He writes that “infrastructural distributions—and the distributional injustices embedded in them—are shaped around both the physical design of things…and the political design of services…both reproduce[ing] and generat[ing] relations of
economic and spatial inequity” (Tonkiss 2015:387). These systems are therefore implicated in the production and maintenance of social stratifications and exclusions,\textsuperscript{11} in part because infrastructures are already sunk into existing structures (Star 1999). He also argues that infrastructures are financialized, creating and allowing capital flows that “marketize various…systems of provision” (Tonkiss 2015:387). Similarly, Plantin and colleagues (2016) draw attention to the increasing privatization of infrastructures in the neoliberal era, where technologies created and maintained by private companies are creating ubiquitous infrastructure, such as Google’s maps services, on which people are increasingly dependent. Wilson (2016:270) contends that attending to infrastructure refocuses biopolitical questions around how life is managed, provisioned, excluded, and capitalized on from its discursive operations to its institutionalization in infrastructure as “structures that provision needs…in relation to public collectivities or private capitalist markets.”

This dissertation is also centrally concerned with the subjectifying aspects of infrastructure and, following Larkin (2013), I consider how infrastructure requires and produces subjects and how subjectivities are installed into infrastructure itself. Larkin (2013:333) argues that infrastructure creates subjects at an affective level, drawing people into their operations by “enter[ing] into our unconscious and hold sway over the imagination” thereby forming subjects “not just at a technopolitical level but also through this mobilization of affect and the senses of desire, pride, and frustration, feelings which can be deeply political.” Infrastructure, through various tactics, enrolls subjects and produces particular kinds of people (Larkin 2013). Others argue that people themselves can become part of infrastructure (Simone 2004). For example, Tonkiss (2015:389) contends that in certain contexts when infrastructures either fail or are not ever erected, human bodies and human labor become infrastructure itself to “fill in for”
infrastructural systems that have strategically excluded them. In these cases, humans themselves act as “conduits of exchange and connection” and an embodied infrastructure (Tonkiss 2015:389).

Throughout this dissertation, I engage several of these theories of infrastructure to consider how founders and investors approach developing consumer health and wellness technologies as infrastructure-building. I also examine how these actors rely on standards to establish this infrastructure. Following Tonkiss (2015), I explore how capital flows through particular visions of infrastructure and consider how assembling infrastructure is big business and enables (and is motivated by) promises of massive capital accumulation. In addition, I reflect on the kinds of subjects that these technologies require and assemble as infrastructural work (Bowker and Star 1999) and explore how these subjects may themselves be critical components of the architecture of circulation that these technologies promise to assemble. While many of these commentators have elucidated how infrastructures encode and embed politics and social relations, far less attention has been paid to how the assembly of digital infrastructures are increasingly significant economic projects. I contribute to theories of infrastructure by arguing that the work of assembling infrastructure (often in service of future capital opportunities) is critical to the social construction of value in technology. I integrate theories of infrastructure with theories of capital to argue that, in the context of consumer health and wellness technologies, assembling future value in infrastructure allows financers and founders to secure their investments by producing life as a continuous capital opportunity.

**Biomedicalization**

This dissertation is strongly informed by biomedicalization theory, as developed by Clarke, Mamo, Fosket, Fishman, and Shim (2010). This theory posits that technoscience is
fundamentally reorganizing and reconstituting medicine “from the inside out,” producing new forms of knowledge, subjects and subjectivities, practices, and social arrangements (Clarke et al. 2010:2). Biomedicalization points to “the increasingly complex, multisited, multidirectional process of medicalization that today are being both extended and reconstituted through emergent social forms and practices of a highly and increasingly technoscientific biomedicine” (Clarke et al. 2010:47). These changes are situated in larger political-economic shifts in the valuation of life itself, where biomedicine is implicated in the production of new knowledges, new forms of life, and new forms and circulations of capital that are centered on the life sciences and life itself.

I draw on biomedicalization to theorize the implications of how consumer health technologies extend the biomedical gaze into the home and onto the body to subsume all moments of life. Biomedicalization theory helps situate the proliferation of consumer health technologies within the context of political economic shifts and technoscientific advancements that Clarke et al. (2010) argue are reconstituting biomedicine and life itself. The theory thus raises critical questions about how changes in the processes, practices, subjects, and spaces of biomedicine are reflected in and make possible the rise of consumer health technologies. However, I use the empirical example of consumer health technologies to reflect back on the key processes of biomedicalization and consider how this example may offer insights into to how we theorize biomedicalization. In particular, I argue that while biomedicalization theory posits a commodification of health as a key political economic shift that reorganizes biomedicine, my research suggests an assetization of life, as life becomes indefinitely capitalizable and a financialization of life in addition to a corporatization of health. Financialization (described below) refers to a financial orientation to society and life that leverages financial notions and
practices of speculation, derivation, and investment to locate opportunities for and streams of continuous capital accumulation.

Clarke and colleagues (2003; 2010) delineate five key processes through which biomedicalization is constituted: First, they point to changes in the political economy of biomedicine, where an increasingly corporatized, commodified, and privatized health system produces blurred boundaries between public and private. Second, they argue that there is a new emphasis on health (as opposed to illness), risk, and surveillance where health is a status one must work towards (though perhaps never achieve), requiring maintenance through the regular consumption and surveillance of biomedical technologies. Third, they point to the technoscientization of biomedicine effected through and maintained by an increased reliance on computerization, information infrastructure, and the shift from a clinical to a molecular gaze. Fourth, they argue that shifts in biomedical knowledges—how they are produced, consumed, disseminated, deployed, and transmitted—are changing peoples’ relationships with the health system, the actors/institutions involved in producing health information, and responsibilities to consume this information. Lastly, they point to transformations of bodies and identities, where biomedicalization constructs the body as malleable and customizable through technoscientific advances, creating new identities, socialites, and subjectivities around biomedical labels (Clarke et al. 2010).

I argue that all five processes of biomedicalization are manifest in consumer health and wellness technologies; indeed, these technologies may extend these processes and potentially reorganize biomedicine. Devices and apps are fundamentally reconstituting and reconfiguring the economics, spaces, practices, knowledges, and jurisdictions of health. Technology is made a fundamental actant and agent of biomedicalization, rather than just a product of it. This
foregrounds the work that investors and founders design these technologies to perform: the
discourses they animate, the capital they generate, the infrastructure they install, and the subjects
they assemble. Further, biomedicalization makes it possible to approach these devices as
technological not only because of their technical characteristics but also because they organize
and configure knowledge, social relations, and infrastructures.

This dissertation is fundamentally concerned with how political economic forces are
implicated in transformations in health, and particularly explores how economic practices and
logics organize how health is defined and measured. Following Clarke and colleagues (2010:58),
I argue that these equity-financed technologies “shap[e] how we think about social life in ways
that constitute biomedicalization” and how that life is governed, measured and known. This
dissertation seeks to understand these reconfigurations and offers insights into how consumer
health technologies reconfigure how life itself becomes an economic project.

I contend that consumer health and wellness technologies also extend the biomedical
gaze into everyday consumer life—integrating biomedical governance into the intimacy of
consumer home appliances, vehicles, beds, and bodies. They are designed to bring all aspects of
consumer life under biomedical governance and scrutiny. This level of surveillance is pursued
not only in the name of risk, but in the pursuit of life optimization, where life itself becomes a
constant project and moral obligation that requires not only self-regulation but continuous data
collection. In this dissertation, I illustrate how datafication furthers biomedical technologies’
(and technology companies’) “gaze and reach into both the interior of the body and its
behaviors,” which, I argue, is made possible through the strategic assembly and production of
new subjects and subjectivities that consent to a form of governance that works “from the inside
out” (Clarke et al. 2010:70).
Theories of Capital

Multiple forms of capitalism converge to make consumer health and wellness technologies possible. I use several theories of contemporary capitalism to parse the complex entanglements of capital and health technologies and consider their effects.

In this dissertation, I am centrally concerned with the relationship between equity financing and health, as well as how equity financed-consumer health technologies configure life, truths, and subjects. To theorize and understand these relationships, I turn to Kaushik Sunder Rajan’s (2006; 2012) theory of biocapital because it raises critical questions about how value and health can be produced simultaneously and thought of as commensurable.

Sunder Rajan (2006; 2012) argues that biocapital, which he claims is one of many capitalisms, is a particular vantage point and window into how contemporary developments in and the organization of the life sciences and capitalism are co-constituted. He contends that the rise of venture capital-funded life science (which he calls “venture science”) created an entry point of capitalist logics into the life sciences, resulting in what he calls an “epistemic reconfiguration.” He takes the specificities of venture capital financing seriously, and explores how the logics and structure of this particular form of financing comes to organize the life sciences the truths it claims to produce. According to Sunder Rajan (2006), the grammars of the life sciences—what they can articulate about life—become coterminous with those of capitalism in an era of biocapital. Further, he argues that the fetishized truths of venture science interpellate (Western) subjects into “consumers-in-waiting,” patients always already in need of and prepared to consume biomedical interventions such that there is always a market (and market value) for its products. I draw on Sunder Rajan (2006; 2012)’s work to consider how the structure of equity financing organizes the design, development, and trajectories of consumer health technologies as
well as its impact on how life is articulated, governed, rendered, valued, circulated, and capitalized. Additionally, I consider the kinds of subjects entailed in and produced by these technologies and whether or not the notion of patients or consumers in waiting aptly describes or encompasses these subjects.

However, Sunder Rajan, despite his attention to financial actors, fails to attend to the logics and processes of financialization in his theory of biocapital. I center questions of financialization in this dissertation not only by exploring the financial instruments and logics through which life is made valuable in the development of consumer health technologies, but also by situating these technologies in the financial processes of contemporary capitalism—through which financial instruments are become increasingly dominant forms of capital accumulation—that are increasingly critical to capital accumulation in advanced neoliberal economies. Financial capitalism, which is now a hallmark of neoliberal economies, refers to “a pattern of accumulation in which profit-making occurs increasingly through financial channels,” such as derivatives, capital gains, assets, and securities “rather than through trade and commodity production” (Krippner 2005:181). The production of financial instruments in 1970s, such as hedge funds, futures, and options to spur capital accumulation has led to an explosion of financial speculation (beginning in the 1980s) and capital derived therefrom (Foster 2007). The logics of financialized capitalism have pervaded all aspects of social life. Christopherson, Martin and Pollard (2013:251) argue that “not only has money in all its multifarious forms become fully commoditised, traded in and of itself for profit, without reference to the real economy, it has permeated almost every sphere of social and cultural activity…subjecting it to the imperatives of financial markets and institutions.”
Following Birch (2016), I explore the social practices of valuing and valuation in the context of consumer health and wellness technologies to ask what kinds of ideas are understood to be valuable and/or value-generating and why. Birch (2016) argues that science and technology studies has mistakenly focused too much attention on the commodity planned to be produced by life science companies and not enough attention on assets and practices of financial valuation. Indeed, Birch and Tyfield (2013:301) argue that STS scholars have “posited a transformation of modern capitalism without due attention to the transformation of economic and financial processes in modern capitalism” (emphasis original). These transformations have effected very specific valuation practices among political economic actors (such as venture capitalists) that many STS scholars ignore. I take seriously Birch’s (2016) call for science and technology studies to carefully explore how these financial actors in the era of financial capitalism socially construct and negotiate value, often in the absence of profit. Birch (2016) centers these actors and their practices (of financialization, capitalization, and assetization) to foreground how value is made through their social practices rather than inhering in the commodity or discursive claims. He asserts that “what gets valued” and how in the context of equity financed-life sciences requires understanding how value is constructed in particular kinds of assets (e.g., intellectual property) instead of commodities, as most biotech companies do not end up producing any products (Birch 2016:9). By backgroundering the commodity and potential profits and foregrounding financial instruments and future capital opportunities, I use Birch’s arguments to explore how equity investors construct value in future claims rather than on current commodities. Moreover, I situate these technologies within the emergence of financial capitalism and the growth of equity finance, as these trends fundamentally structure practices of valuation.
Lastly, unlike other commentators, such as Schüll (2016) and Crawford and colleagues (2015), I also consider theories of information capital in relation to biocapital and finance capital to consider how these devices create new capital opportunities through continuously collected data. Scholars of information capital posit that data about consumers and even life itself are increasingly becoming the “raw material for the production of consumer representations as information commodities,” (Zwick 2015:493) such that consumers are made into “resources to be themselves cultivated, processed, and consumed” (Cohen 2015:24). Thus, following Zwick (2015) and Cohen (2015), I integrate theories of information and financial capitalism, rather than focusing on commodity capitalism, to consider how the social construction of consumer health and wellness technologies, the value they are understood to generate, and the social and economic work that they perform are tied to how they facilitate the extraction of capital from consumer data.

I draw on media and marketing studies scholars who have argued that information capitalism, particularly with the advent of Web 2.0 technologies,\(^{13}\) has given rise to the “prosumer,” a capitalist subject who produces and consumes simultaneously. Scholars in this arena often classify datafied consumer activities as digital labor, such as content sharing on social media platforms, that is often exploited for private gain (Terranova 2013; Till 2014; Charitsis 2016; Fuchs 2010; Ritzer 2014; Zwick 2015; Zwick and Bradshaw 2016). I leverage these concepts to consider how consumer health technologies’ value are tied to how they facilitate the extraction of capital from consumer data as well as how all moments of a tracked life are rendered productive. Zwick (2015:493) contends that in the era of informational capitalism, even non-actions, such as not using one’s credit card, is datafied, therefore allowing “all of life [to be]…rendered productive, or perhaps prosumptive, at all times. Moreover, all of
life can generate a surplus for capitalists.” Both Charitsis (2016) and Zwick (2015) argue that this form of informational capitalism can create the subject as an object of knowledge and a subject who prosume themselves. While these scholars raise critical questions about how this form of capitalism necessitates presumptive subjects, this literature does not foreground how consent to presumptive and increasingly surveilled, datafied life is produced or maintained such that subjects prosume themselves. Unlike these scholars, I consider how consent to the incredible surveillance that consumer health technologies effect is produced as well as how such consent is critical to constructions of value in these devices and the futures they assemble. Similar to some of the critical digital health scholarship, these scholars tend to focus on the generation and exchange of data when theorizing value in information capital and fail to account for how value may be constructed in the infrastructures and infrastructural work that maintain and extend this form of capitalism. Theories of biocapital and financial capital similarly neglect the role if capitalized infrastructures in the reproduction and extension of these forms of capitalism as well as how value can be constructed in the assembly of these infrastructures. Thus, while I draw on this scholarship, I contribute to these theories of capitalism by elaborating how the assembly of infrastructures to advance and extend these capitalisms by securing the capacity to extract diverse value from life itself into the future, crucially produces value in the present.

RESEARCH METHODS

Consumer health and wellness apps and devices are emergent technologies that are imagined and made valuable by a diverse set of actors. Following Deborah Lupton’s (2014a:618) call for further sociological research on the “practices and tacit assumptions” of those who design and develop these technologies, this dissertation engages these very actors. Further, I am
centrally concerned with how value is imagined in these technologies and how assumptions about value (both social and economic) shape their trajectories. I therefore also center the perspectives of investors, whose interests can fundamentally shape what counts as a viable consumer health and wellness technology.

This dissertation addresses the following questions: How and why are health technologies being developed in the consumer sector? How and why are these technologies considered valuable by those who develop and invest in them? What futures are imagined in and being pursued through the development of these technologies? How are these technologies financed and what are the implications of these forms of financing on their development? In answering these questions, I describe the kinds of capital, ideologies, subjects, and infrastructures that both constitute and are constituted by these technologies and their futures.

To examine the practices, assumptions, and priorities of the investors and developers that bring these technologies into existence, this study integrated two qualitative data collection methods: 1) ethnographic observation and 2) in-depth, semi-structured interviews. This study was submitted to and approved by the UCSF Committee on Human Research prior to data collection.

*Ethnographic Observation:*

As described above, ethnographic observation at conferences, “meet-ups,” and pitch events gave me critical exposure to the social organization, practices, relationships, networks, priorities, and strategies of both developers and investors involved in the consumer health and wellness technology sector. Moreover, attending these events became a crucial recruiting strategy for this project. Through these observations, I was also able to assess whether my
research adequately covered relevant literature, emerging ideas and debates, actors implicated, and relationships formed around these technologies.

I conducted ethnographic observations at various relevant meetings and events in the San Francisco Bay Area, including: pitch events, where founders pitch their companies (often in very early stages of development) to panels of angel investors and venture capitalists and receive feedback; digital health “meet-ups,” which usually involve pitches and presentations by local digital health and health technology entrepreneurs and opportunities to network within these communities; and digital health conferences, often sponsored by institutions and companies, such as a university, featuring public and private sector speakers on contemporary developments and policy issues regarding health technology innovation.

I initially identified many of these events through web searchers and event management websites, such as Eventbrite. I also used the website meet-up.com, which hosts online communities and facilitates in-person events, or “meet-ups.” I joined several of these groups on the site, such as “Bay Area Digital Health Meetup” and “Health 2.0 San Francisco,” so that I could be notified of and register for their events. Lastly, I signed up for e-mail listservs, such as “AngelLaunch,” as many groups advertise their events as well as partner events via email.

All of the events I attended required online registration, which usually costed $5-20 per event. Most of the pitch events and meet-ups lasted 2-4 hours, with at least 30 minutes of networking. The conferences were usually all-day events and sometimes included “expos,” and “demos,” where entrepreneurs discussed and often displayed their technologies at various booths. These events were hosted in a variety of locations, including: headquarters of technology companies, law offices (law firms sometimes co-sponsored events), co-working facilities, and
conference venues, such as the UCSF Mission Bay Conference Center. I observed 20 events between May 2015 and November 2016.

At these events, I took extensive notes on the setting, audience members and meeting participants, and the theme of the event. At events that involved startup pitches, I noted the types of companies pitching as well as the advice offered and questions posted by investors on the panel, and how audience members and investors received these pitches. I observed the types of investors who attended these events, including the types of firms they worked at, the stage of financing they provided, and their areas of specialization. I recorded the products or company features that entrepreneurs foregrounded in their pitches as well as the language they used. At meet-up events, where entrepreneurs often shared their product development and financing experiences, I attended to how entrepreneurs framed their products, the kinds of advice they offered, and challenges they narrated. After these events, I typed up handwritten field notes and elaborated on themes and questions. In some cases, I also wrote memos on these notes to consider how these data related to or contrasted with themes emerging in my interviews.

In-Depth, Semi-Structured Interviews

Semi-structured, in-depth interviews provided rich narratives of investors, founders, and startup employees’ perspectives on the value, future, and promises of consumer health and wellness technologies. Through interviews, I could explore these actors’ worldviews, goals, and assumptions and understand how they rationalize and situate these technologies and their trajectories. Because I conducted ethnographic observations and interviews concurrently, I also used the interviews to explore themes raised during observations.

To be eligible for an interview, participants had to be a founder or employee of a health technology company or a technology company that is involved in the health sector, or an
investor, such as a venture capitalist or angel investor. Most interviewees were identified and recruited at events I observed. Many of the investors I interviewed were panelists at pitch events or conferences. Most founders interviewed were event participants who pitched their companies at meet-ups and pitch events and/or held demos/expos at conferences. While I also attempted to employ snowball sampling methods to gain access to additional participants in a founder, employee or investor’s network, most interviewees did not refer me to others in their networks. I also relied on my own professional network to recruit interviewees. Lastly, I also reached out to potential participants based on contact information I located online.

All interviewees were sent emails that described the project to invite them to participate. If they were willing to participate after initial email exchange, an interview was scheduled and participants were emailed a study information sheet and sent a formal invitation email. Though most interviews were conducted in person, several participants elected for phone interviews, usually due to time constraints. At the start of each interview, participants were asked to review the study information sheet and give verbal consent to participate. At the end of each interview, participants were asked whether they would like to have the interview be on or off the record, though some indicated their preference at the start of the interview. While some participants elected for on-the-record interviews, several requested that I obtain approval from them directly for quotes or data attributed to them in any subsequent reports or papers. To avoid these complications, I decided to give all participants pseudonyms and have removed references to their companies/workplaces, as I did not feel that their name and workplace affiliations were necessary to the analysis. I conducted a total of 36 interviews between June 2015 and September 2016 (see Appendix A for participant list). Most interviews lasted about one hour and 35 of the 36 interviews conducted were audio-recorded. In one instance, my participant was not willing to
be recorded but I was able to take notes throughout our conversation. Audio recordings were transcribed by an outside transcription service and data analysis was conducted on these transcriptions, in addition to post-interview field notes written after each interview.

Interviews with founders revealed rich narratives about the development of their companies, their commitments, interests in health, and views about the value and futures of consumer health and wellness technologies. They sometimes provided comprehensive detail about the day-to-day operations of running a startup, the processes involved in securing funding, the funding climate for their products and ideas, and their perceptions of the general impact of consumer health and wellness technologies as well as the impact of their technologies in particular on health practices and healthcare. I conducted a few interviews with a variety of employees at some health and wellness technology companies, often recruited through my professional network. Many of these employees worked at leading companies in this sector, where I did not have access to founders. Many employees I spoke with were in marketing and communications and they explained the practices and challenges of marketing their technologies, market receptiveness, and the future they envision for their companies and the sector as a whole. Interviews with investors revealed the complex ways investors understand and construct value in technologies and the futures they make possible. Additionally, investors’ worldviews and assumptions about health, healthcare, and the capacity of equity-financed companies to “disrupt” healthcare were also uncovered. Taken together, these interviews elucidated how and why consumer health and wellness technology companies are understood to be valuable as well as the kinds of futures they set in motion, both key themes explored in the remainder of this dissertation.
Additional Documents

In addition to these data sources, I also collected documents and media from major consumer health and wellness technology companies, including the companies at which some of my participants worked, to contextualize interview and ethnographic observational data. These included screenshots of website imagery, filings with the Securities and Exchange Commission, earnings call transcripts\(^\text{16}\) (conference calls between a publicly traded company and its investors reporting the company’s financial results during a given period), and reports and slide presentations the companies had released. I occasionally discussed ideas or imagery from a company’s website with the company’s founders or employees during the interview to better understand how they publicly represent their company. I also collected slide-based presentations from entrepreneurs that were emailed to participants following meet-up events where they had presented about their companies and products. Some of the events I attended at law firms included slide-based presentations or physical document packets about financing strategies for startups. In these cases, I collected these documents or downloaded slides after the event. I also collected regulatory documents, such as guidances from the Food and Drug Administration, and reports from the Federal Trade Commission and the Securities and Exchange Commission.

Analytic Approaches

All data were coded and analyzed using constructivist grounded theory methods (Charmaz 2006) and data analysis was performed simultaneously with data collection. Text from all interview transcripts; field notes taken before, during, and after conferences and meetings attended; and key documents, visual media, and website content collected were analyzed and coded together using ATLAS.ti, a qualitative data analysis software.
Constructivist grounded theory is a highly inductive method of qualitative data collection and analysis that aims to construct a theory, or an “abstract theoretical understanding of the studied experience,” of a particular phenomenon that is grounded in empirical observation and is necessarily interpretive (Charmaz 2006:4). Charmaz (2006) argues that constructivist grounded theory explicitly challenges the notion the researcher discovers data and theories and instead argues that researchers are intimately involved in the research process and the resulting data. She thus emphasizes that researchers “construct our grounded theories through our past and present involvements and interactions with people, perspectives, and research practices,” thereby rendering an interpretive picture of the social world (Charmaz 2006:10). As an analytic strategy, grounded theory was well suited to this project because it attends to both the larger social environment in which a phenomenon is situated as well as how actors respond to this environment. Moreover, grounded theory analytic methods allow diverse qualitative data to be analyzed together (Charmaz 2006). In grounded theory, data collection and analysis occur simultaneously to allow findings to inform and direct data collection (Charmaz 2006). Grounded theory stresses a constant comparative method of qualitative analysis, in which analysts compare data collected throughout the research process and allow ongoing analyses to inform and direct the research. Using this method, I was able to revise my interview questions and follow up on themes revealed through coding and memoing in subsequent interviews.

Following grounded theory analytic methods, all qualitative data were coded, that is, tagged with codes or labels to indicate actions, meanings, themes, dimensions or aspects of different phenomena, and similarities and differences across data (Charmaz 2006). Subsequent coding processes were used to categorize and sub-categorize the data and existing labels, focusing on the relationships among categories. Additionally, analytic memos were written
regularly throughout the research process. Memos are a critical element of grounded theory analysis because they encourage ongoing analysis and allow the researcher to monitor hypothesis, reflections, and generative questions throughout (Charmaz 2006).

Additionally, I employed tools from situational analysis to complement grounded theory analytic strategies detailed above. Situational analysis specifically focuses on the multiple actors, discourses, objects, and positions involved in a particular social phenomenon and allows the researcher to account for and center this diversity in the analysis (Clarke 2003; 2005). Situational analysis was therefore particularly useful for this project because it involved multiple actors with potentially differing interests and stakes in the consumer health and wellness technology sector. Situational analysis also attunes the analyst to how objects and technologies can shape social situations. I approach consumer health and wellness technologies as nonhuman actants, meaning that these technologies, though not human actors, possess agency to organize and shape human actions and interactions (Clarke 2005; Pinch and Bijker 1984). Because situational analysis centers the way these technologies can act on situations, thereby “taking the nonhuman in the situation explicitly into account” this analytic strategy proved incredibly useful (Clarke 2005:61).

The analytic strategies involved in situational analysis include several types of mapping exercises. The first, situational mapping, focuses on and generates analyses of the relations among various actors, objects, and discourses. I found situational maps to be useful in keeping track of the ever-growing context in which these technologies exist and the diverse array of institutions, actors, and objects that make these technologies possible. Second, social worlds/arenas mapping explicate and diagram the different entities that are involved in a phenomenon and their collective commitments. Because this dissertation also explores the relationships, particularly financing relationships, and practices that condition the possibility of
these technologies, social worlds/arenas maps allowed me to attend to these relationships and the varying commitments of those involved in this sector. I used these mapping strategies as tools to stimulate new ideas and locate perspectives, actors, discourses, and objects that I might have missed when coding. These maps allowed me to regularly step back from the details of the interviews and analyze the consumer health and wellness technology sector as a series of entities and as a situation.

Navigating the Social Worlds of the Consumer Health and Wellness Technology Sector

The technology sector and the investing industry that co-constitute consumer health and wellness technologies involve socially and economically powerful actors and institutions. “Studying up” in this community required acclimating to Silicon Valley and the culture of the technology sector in order to successfully recruit investors and startups. Diana Forsythe (1999) has argued that “studying up,” which involves relocating “fieldwork and fieldworkers to powerful institutions in society,” can have “major implications for the conditions under which field research takes place and the kinds of relationships that develop between [researchers] and their informants” (Forsythe 1999:6). In the research contexts Forsythe (1999) describes, social worlds between researchers and participants can overlap, participants may have significantly more social and economic power than the researcher, and participants may take an active interest in how they are represented in research. Though I have familial ties to the larger technology sector and therefore some exposure to the broader arena in which consumer health and wellness technologies are situated, I had little professional experience in this community. Learning how to navigate the social worlds of these technologies and the powerful actors involved was critical to the success of this project and I devoted considerable efforts to familiarizing myself with these worlds.
When I began fieldwork, I felt awkward attending industry events, as I was unsure of how to explain my background, presence, and interests to a community fairly unfamiliar with sociological research. However, conducting observations at public startup pitch events gave me critical exposure to this sector and its actors, norms, language, and its social organization. Most events were heavily male dominated and, at pitch events (where startups pitch their products and companies to investors and other entrepreneurs), the majority of attendees were startup entrepreneurs hoping to network with each other and investors. Investors typically attended these events as panelists providing feedback and advice on pitching, rather than as audience members. Because equity finance is often facilitated through networking and referrals (described in depth in Chapter 2), networking is an important feature of these events.

At first, I assumed that entrée would be difficult to establish, given the seemingly insular and protected networks that determine how capital moves in the tech economy. However, because this sector is organized around the assumption that fundable and successful ideas can come from anywhere, anyone, and at any moment, this community was far more accessible I had anticipated. While founders were easy to approach, as they were often enthusiastic to promote their products, investors were often inundated with entrepreneurs seeking referrals, counsel, and potentially a relationship after a panel. Frequently, I found myself in competition with these entrepreneurs as we all vied for investor attention. In order to physically be seen and get a moment of investor time, I had to wear high heels, don professional attire, and exude confidence. The technology sector and its investors can move at an extremely fast pace, and I quickly learned that to secure an investor’s attention—even for a minute—required translating my research into a format with which they were familiar: a highly crafted, pithy “pitch,” even in regular conversation. Attendees at these events were typically founders or entrepreneurs, lawyers, and
investors, and they could be sorted by their attire: Investors and lawyers tended to dress professionally, while founders, who were often young men, typically dressed quite casually. Thus, by dressing professionally, I appeared more like an investor or lawyer than a founder and therefore felt more powerful at these events. Perhaps because of this, founders, particularly of early stage companies, sometimes assumed that I was well-connected in the venture capital industry.

My position as a researcher at UCSF helped me gain entrée with investors as well. Investors in Silicon Valley, particularly those who specialize or have specialized in medical devices, are familiar with UCSF and its support of entrepreneurship among (some of its) students and faculty. The campus hosts a branch of the California Institute for Quantitative Biosciences, which facilitates research and technology commercialization at UCSF as well as a very active entrepreneurship club with close ties to the venture capital industry and angel investors. Thus, I suspect investors assumed that our interests and commitments were somewhat aligned when I introduced myself as a UCSF sociologist. Because UCSF partners with digital health startups for clinical research and patient services, founders were sometimes familiar with UCSF as well. As these relationships are wide-ranging and not transparent, in a few instances I was not aware of a company’s partnership with UCSF until founders revealed it during the interview, often assuming I had known. These partnerships or the prospect of potential partnerships may have influenced founders’ interest in speaking with me.¹⁷

Lastly, I assumed that this sector would be dominated by white men, and I was unsure of how I would gain access as a South Asian woman. However, I found that many investors and founders were of South Asian descent in Silicon Valley, and, as a result, I felt far less foreign in their spaces than I anticipated. I realized that their presence gave me much more confidence as I
learned to navigate these communities because no one questioned my presence as both a UCSF researcher and a South Asian person. Many of my participants were South Asian or South Asian American and though our shared ethnic background never came up in our conversations or during interviews, I personally felt quite comfortable approaching them after events.

OVERVIEW OF THE DISSERTATION

A central theme of this dissertation is exploring the work that contemporary consumer health and wellness technologies perform. My participants view these devices to be in their infancy and therefore situate the work these devices perform in a much longer trajectory. For startups and investors, these devices are valuable in the present for the futures they make imaginable—and much of the work that these devices perform is in service of those futures. I explore the different facets of this work throughout the dissertation.

In Chapter 2, I trace the consumer electronic infrastructure and financing strategies that I argue together make consumer health technologies possible and contend that speculation around future value is built into how capital is advanced in the present, which critically shapes these technologies’ trajectories. In the first half of the chapter, I describe how imperatives to miniaturize electronics for increasing portability spurred developments in power and circuitry and advancements in networks and communications that laid the groundwork for contemporary iterations of consumer health and wellness devices. I argue that these developments, particularly the emergence of the smartphone, which transformed mobile telephony into mobile computing, gave rise to devices that were designed to completely subsume consumer life. I thus contend that these devices, which were designed to be relevant to all moments of consumer life, established the possibility of rendering life continuously and were therefore critical to the eventual development of these devices as consumer health technologies. Thus, unlike other
commentators, such as Lupton (2014a; 2016; n.d.), I situate consumer health and wellness technologies within the markets, infrastructures, legacies, and trajectories of the consumer electronics sector.

In the second half of Chapter 2, I contend that how equity financing is structured and rationalized fundamentally shapes the development of consumer health technologies and the social, cultural, and economic work that they are imagined to perform. Equity finance—namely venture capital—is thus equally as crucial as the technical conditions to the development of consumer health and wellness technologies. As I have described in this introduction, the critical digital health scholarship fails to attend to the role of this particular form of capital in the development and valuation of consumer health technologies. I illustrate how particular neoliberal reforms make venture capital possible by routinizing and rationalizing failure in the name of experimentation, thereby building speculation of potential and future value into the development of consumer health technologies and their present value. By taking equity finance seriously and foregrounding its structure and logics, in this chapter and in the whole dissertation, I complicate how these technologies and their data are constructed as valuable in the of absence profit and in the presence of failure. I show how equity finance provides a window into the myriad ways that value is negotiated and constructed in these technologies.

In Chapter 3, I argue that, despite their failures, investors and founders consider consumer health technologies to be valuable because they assemble the infrastructure for a future in which these devices become part of the quotidian fabric of consumer life. I approach their value through what I call the “wearable paradox”: many leading consumer health technologies are plagued with high user abandonment and many inaccuracies and yet generate billions of dollars of value. Using this paradox as a way into the social construction of value in these
technologies, in this chapter, I explore how these devices ‘work without working,’ thereby foregrounding the infrastructural work that these technologies perform, despite not working well. I draw on theories of infrastructure to illustrate how economic and technical standards that are being set through these devices create what I call the groundwork for the future. In so doing, these technologies stabilize ideas about how health should be known, collected, measured, practiced, and valued in the background—in ways that are increasingly hard to see. I show how in developing and financing these technologies, investors and startups are advancing a particular vision of the future that is being set in motion in the present. I therefore argue that to adequately attend to (and potentially intervene on) the work these devices perform, sociologists must critically investigate these claims on the future.

In Chapter 4, I argue that consumer health technologies proliferate in part because consumers are being enrolled into the lifestyles and subjectivities through which these technologies make sense and feel self-evident. I contend that this enrollment creates a social infrastructure of the future by inculcating subjects into the logics of a tracked life in the present. In this chapter, I argue that consumers must be made to consent to the incredible surveillance that these devices effect. I thus illustrate how consent is itself installed in and through infrastructure—through the strategic creep of default features and quiet standards that come to feel natural and make these devices seem both normal and necessary. I draw on theories of ideology and subjectivity to explore how consumers are made to willingly submit to the governance entailed in these technologies. I thus contend that another aspect of the work that these technologies perform in the present is enroll and install these willing subjects in the present for the future. These technologies crucially render a new kind of lifestyle accessible, desirable, justifiable, and self-evident in the present, thereby carefully inculcating subjects into the logic of
an increasingly tracked and optimizable life. Throughout this chapter, I show how assumptions about subjects and the strategies designed to inculcate them into the logics of these devices are informed by behavioral economic principles (also described by Schüll 2016) of “choice architecture” and “nudges.” Lastly, I illustrate how the production of these subjects is an economic goal that produces these technologies as vital—as critical to life itself for life—in order to establish and broaden markets and secure investor interest.

I conclude the dissertation by summarizing the theoretical contributions and implications of consumer health and wellness technologies for understanding the entanglements of contemporary health and contemporary finance. I argue that these technologies are implicated in a financialization of life that renders life an asset as well as a biopolitics of venture capital that aligns the health of the population with the health of the fund. I contend that a logic of routinized failure of both consumer health and wellness technologies and equity financing allow both technologies of finance and technologies of health to capitalize on and simultaneously fail consumers over and over again; however, because these entangled failures are constructed as critical stages of innovation, they will always already work (generate value for investors) without ever actually working.
CHAPTER 2: THE TECHNICAL, ECONOMIC, & REGULATORY CONDITIONS OF POSSIBILITY

INTRODUCTION

Contemporary consumer health and wellness technologies exist in part because of specific technological advances and financing mechanisms that together condition the possibility of these technologies. Over the past decade, these technologies have proliferated in the U.S. consumer sector, and because the vast majority of Americans now own smartphones, most have access to—and in some cases cannot disable—activity trackers and mobile health applications.\(^{18}\) Thus, these devices have become ubiquitous and standardized in American society. However, specific technical, regulatory, and economic, conditions have made this ubiquity both imaginable and achievable. As such, I consider these conditions to be the foundation for the phenomenon of interest of this dissertation. This background thus explores the largely consumer electronic infrastructures, technical foundations, and financing strategies that together create not only the possibility of these technologies but shape the trajectories imagined in them as well. In addition, much of this dissertation considers how particular futures are set in motion in the current iterations of these technologies. Thus, it is crucial to understand why and how futures have come to structure financing strategies in the technology sector. This chapter is meant to situate consumer health and wellness technologies in the infrastructures, markets, financing, legacies, and trajectories of the consumer electronics sector and position this sector as critically constitutive of these technologies.

I begin with the technical conditions —from communication infrastructure to circuitry—that undergird the development of consumer health and wellness technologies and specifically
cover the emergence of consumer wearables and the smartphone. In the second section, I provide a background on equity finance, including angel investing and venture capital, two of the most common sources of capital for startups that develop consumer health and wellness technologies. I parse the different sources of capital, explain the economic role of these financing strategies in the financial system, and consider the neoliberal policies and reforms that not only make this kind of financing possible but also through which it is rationalized. Throughout this chapter, I aim to situate consumer health and wellness devices in the technical and financial legacies that intimately shape their contemporary development and the futures they animate.

THE TECHNICAL FOUNDATIONS OF CONSUMER HEALTH TECHNOLOGIES

Consumer health and wellness technologies are only possible through a variety of technical innovations in computing, miniaturization, communications, and sensing. To better understand what these technologies are designed to do in the present, in this section I explore the technical conditions that make consumer wearables and mobile health apps conceivable and possible. As there is limited scholarly literature that documents the recent history of smartphone and wearable technology, I use a variety of sources to tell this story. These include: the Institute of Electrical and Electronics Engineers’ (IEEE) journals on the technical operations and some historical background of many of these innovations; the IEEE-affiliated Engineering and Technology History Wiki; industry-sponsored journal articles; accounts from popular media sources, such as TechCrunch and The Economist; and journalistic accounts of the smartphone industry. This account focuses on the emergence of consumer wearables and the smartphone, two devices that my participants argue were critical to the development of their technologies.
A HISTORY OF CONSUMER WEARABLES

- 1961: FIRST WEARABLE COMPUTER
- 1972: DIGITAL WRISTWATCH
- 1975: CALCULATOR WRISTWATCH
- 1981: BACKPACK-BASED WEARABLE COMPUTER
- 1987: DIGITAL HEARING AID
- 1989: HEADBAND COMPUTER DISPLAY ("PRIVATE EYE")
- 1990: SMARTWATCH (SEND & RECEIVE MESSAGES)
- 1994: WIRELESS Webcam
- 1999: WRISTWATCH PHONE
- 2000: BLUETOOTH HEADSET
- 2002: WEARABLE PERSONAL COMPUTER
- 2003: WRIST-BASED PERSONAL DIGITAL ASSISTANT
- 2003: GARMIN WEARABLE ACTIVITY TRACKER
- 2006: NIKE SHOE-INSERT ACTIVITY TRACKER
- 2008: FITBIT ACTIVITY TRACKER
- 2012: PEBBLE INTERNET-CONNECTED SMARTWATCH
- 2013: ODYSSEY GLASS AUGMENTED REALITY HEAD DISPLAY
- 2015: APPLE WATCH (SMARTWATCH)
- 2016: OCULUS RIft VIRTUAL REALITY HEADSET

Figure 2.1
As Figure 2.1 indicates, the category of consumer wearable computers and devices encompasses a variety of technologies that date back to the 1960s. While many of the early wearables were not economically successful, as these technologies developed and became increasingly sophisticated, the market for these devices has grown significantly. While the wearables included in Figure 2.1 are not comprehensive, they illustrate the history and breadth of consumer wearable computers. With each successive decade, wearables, which are largely consumer devices, have become increasingly computationally sophisticated and have made computing increasingly portable. Such developments have enabled an increase in the development of wearable devices since 2000, as Figure 2.1 indicates. Because this dissertation focuses on consumer health and wellness technologies, the wearables I will focus on for the remainder of this chapter are devices intended for consumer health and wellness, rather than medical, computing, and/or augmented and virtual reality devices. In what follows, I will explore some of the enmeshed and co-constituted regulatory and technical conditions that, together, have been critical to the development and proliferation of wearables.

What Makes Wearables Possible

A key feature of wearables is their portability—wearables, from their inception, were meant to be portable computing devices. A crucial technical challenge in the production and development of wearables, then, is how to miniaturize technology enough that they can be portable but still interactive. As a result, technological developments in miniaturization, networked communications, and remote storage, that were often facilitated by regulatory changes, created the foundations for wearable evolution and eventual proliferation.
Power & Circuitry

First, these portable technologies require portable power sources. Additionally, because these devices are designed to be worn continuously, they must maintain their charge for a long period—often at least several months—which simultaneously allows these technologies to integrate into daily consumer life more seamlessly. According to Zeagler and colleagues (2014), the earliest wearables used lead-acid gel cells and nickel-cadmium batteries, which were commonly used in consumer electronics at the time. While these batteries were rechargeable (unlike many other chemical batteries), they were large and inefficient. The late 1990s saw the emergence of the lithium-ion battery, which was much smaller than lead-acid gel cells and more efficient. These smaller batteries made it possible to develop smaller, more portable electronic devices, such as the mp3 player and smaller cellular phones. Additionally, the invention of 3 and 5-volt DC-DC power converters in the late 1990s was critical to the development of wearables, as they emitted far less heat than lead-acid gel batteries when converting power for circuitry. Because wearables are designed to be worn on the body, these technologies must generate as little heat as possible. Lithium-ion batteries are still the standard power source in contemporary wearables such as Fitbit activity trackers.

Integrated circuits and microprocessing also allowed for the miniaturization of wearable devices and the development of cellular and smartphones (described below). An integrated circuit is a “slice of silicon…that has been specially processed so that a tiny electric circuit is etched on its surface. The circuit can have many millions of microscopic individual elements…all electrically connected” (Engineering and Technology History Wiki 2015b). These circuits, which were invented in 1950s, eventually gave rise in 1971 to microprocessors, a type of computer processor that houses the device’s central processing unit in a single chip (integrated
circuit) (Betker, Fernando, and Whalen 1997). Prior to microprocessors, small computers required several different circuit boards using many integrated circuits. The emergence of the microprocessor, originally designed for calculators, allowed for increased miniaturization of computing devices like wearables and the smartphone by requiring less space within the device and less power to run.

Networking Technologies for Wireless Communications and Data Storage

Perhaps less tangible but as important to the possibility of consumer wearables is the development and increased sophistication of networking technologies—including consumer Wi-Fi, Bluetooth, cloud computing, and GPS. These form the critical infrastructure for consumer wearables and have made possible and standardized external data storage—where data is stored or managed by the company (or a third party) and not the consumer who owns the device—in the interest of portability. Many of these networking technologies began as military tools that, through federal deregulations, became available for commercial development throughout the second half of the 20th century. Federal policy is therefore equally critical to the possibility of wearables.

Consumer Wi-Fi networks were made possible through a series of regulatory and technical developments. In 1985, the Federal Communications Commission (FCC), which already regulated radio frequencies, articulated rules governing “spread spectrum 20 communications" in an effort to "enable new commercial [rather than military] wireless communications products and services" based on "the extensive development work done to that date by the US military on spread spectrum" (Negus and Petrick 2009:2). In this monumental 1985 ruling, the FCC identified three bands of the wireless spectrum that had been designated for
industrial, scientific, and medical fields, and released them for commercial use without licensure with the FCC. This ruling was pivotal in spurring the development of consumer Wi-Fi and was unprecedented as there was little unlicensed spectrum at the time (Anonymous 2004). The Institute for Electrical and Electronics Engineers (IEEE) developed a standard for wireless communications on these spectrums. In 1997, several companies created an alliance to ensure that devices adhered to these standards so that devices from different companies could communicate with each other. This standard, 802.11b, was dubbed “Wi-Fi,\(^{21}\)” and has been widely integrated into consumer and enterprise technologies.

Bluetooth technology, another wireless technology standard, allows technologies like wearables to communicate with a companion web-based or mobile application rather than housing a full-fledged interface on the device itself. Bluetooth is thus equally crucial for wearable portability as other networking technologies. The standard uses radio frequencies to allow devices to communicate wirelessly with each other over a short distance. Developed in 1994 and standardized by an alliance\(^{22}\) of technology companies in 1996, Bluetooth works through a chip installed in the device that allows it to communicate with other devices containing the chip (within about 100 meters), regardless of manufacturer. Many consumer wearable devices use Bluetooth technology to communicate and wirelessly sync data with smartphones, which serve as an interface for the consumer.

The emergence of cloud computing is also critical to the possibility of portable consumer wearable devices. (Regalado 2011; Wei 2014). Prior to cloud computing, most devices, such as personal computers, stored data for applications and programs on the device itself. Cloud computing, a term coined in 1996, allows devices to store data remotely in “the cloud,” typically a remote system of servers. Wang et al. (2010:139) define the cloud as “a set of network enabled
services, providing scalable...inexpensive computing infrastructures on demand, which [can] be accessed in a simple and pervasive way.” Thus, while the cloud may sound like a floating, ethereal phenomenon, it is actually made possible through physical information technology infrastructures—typically in the form of physical server farms (described in depth by Hu 2015). The pervasiveness of internet-connected devices as well as the ubiquity of digital cellular networks and Wi-Fi has made it possible for these kinds of devices to continuously interact with remote servers to upload and download data such that it can be remotely stored. Amazon Web Services, the cloud computing infrastructure provided by Amazon.com, Inc., is one of the largest facilitators and providers of cloud computing services, and many consumer technology companies host their users’ data on Amazon’s cloud. Indeed, several of these companies can only exist because of Amazon Web and similar services, as it allows developers to purchase remote storage space from large technology companies rather than erecting and managing their own servers, which could be prohibitively expensive.

The Global Positioning System (GPS)\(^{23}\), a satellite-based navigation system that provides a person or object's three-dimensional position and time, is also central to how many wearables function, as continuously tracking movement and distance is often a key feature. GPS, which is a US-owned utility, was first developed as a military technology\(^{24}\) in the 1960s to track Soviet satellite movements and was not available for civil use. However, after the Soviet military shot down a passenger aircraft over Soviet airspace in 1983, President Ronald Reagan signed an executive order authorizing the Federal Aviation Authority to develop a version of GPS for civilian use to prevent this kind of incident in the future\(^{25}\). Nonetheless, GPS was not widely available for civil and commercial use until 2000 because of a policy called “Selective Availability,” which entailed an "intentional degradation of public GPS signals implemented for
national security reasons” (National Coordination Office for Space-Based Positioning, Navigation, and Timing 2016). President Bill Clinton discontinued this policy in 2000, thereby making GPS signals functional for commercial and civil use. Thereafter, GPS signal receivers were developed and implemented in consumer devices, including mobile phones and activity trackers, and have since become a standard feature.

The Foundations, Emergence, & Impact of the Smartphone

Smartphone mobile devices and wearable technologies have an integrated history, as the development and widespread uptake of smartphone mobile devices spurred the development of digital cellular networks that are critical to the operation of wearable technologies. Moreover, many of the technical developments I have already described, motivated by increased miniaturization and portability, have also been integral to the development and proliferation of smartphones. Improvements to digital cellular networks led to the ubiquity of high-speed mobile networks, making it easier for devices like consumer health technologies to download and upload user data to remote servers. Thus, while early wearables "had to be mostly self-contained" and could not rely on public networks to access and store data, the advent of consumer Wi-Fi and digital cellular networks made further miniaturization and portability possible because these technologies could wirelessly communicate with the cloud to operate (Zeagler et al. 2014:22).

As described above, most popular wearables include companion mobile apps that form a critical interface through which consumers can engage with the device and its data. In addition, many stand-alone mobile apps also fall into the category of consumer health and wellness technologies. These apps rely on user input and sometimes phone sensor data to measure and analyze consumer health and wellness, such as apps that count calories, store personal health records, and track mental health indicators. In what follows I will describe the emergence of the
smartphone and some of the key conditions in the smartphone’s development that make consumer health and wellness technologies possible.

The Emergence of Cellular Phones and Networks

Crucial developments in cellular technologies, beginning with the cellular phone that first appeared in the United States in 1973 (the Motorola DynaTac), set the stage for the current ubiquity of smartphones in the U.S. consumer market, which now nears market saturation (Anderson 2015). Cellular phones run on cellular networks, which are based on specific radio frequencies that are regulated by the FCC. The FCC designated some of the spectrum towards the development of wireless phone communication as far back as the 1940s, however it was not until the 1960s that private sector engineers began researching and developing these networks in anticipation of its market potential. The “cellular network” was one model put forth by these engineers, in which a geographical region is split into smaller regions—called cells—that are typically 10 square miles. Towers (base stations) are erected to cover these cells, where adjacent towers run on different frequencies but those frequencies can be reused within a geographical region. This allows for what is known as “frequency reuse,” where many people are able to use phones on the same frequencies simultaneously. It also allows the signal to be handed off from tower to tower as the phone-user moves, allowing them to make calls while in motion. AT&T submitted this plan for an analog cellular network to the FCC in 1971. The FCC approved the cellular design of wireless communications and allocated “two swaths of frequencies…to cellular telephony” in 1981 and the first cellular network was established in Chicago in 1983 (Engineering and Technology History Wiki 2015a).

Once this analog cellular network (1G, or first generation) was available, mobile communications became increasingly popular among American consumers, which put pressure
on the network. The FCC authorized additional parts of the spectrum for cellular use in the 1990s and asked companies to develop more efficient use of the network, which led to the second-generation (2G) development of digital cellular networks in the early 1990s. Digital transmission systems increased the number of channels available within a cell so that the network could handle more traffic. Moreover, digital cellular networks require less power from the device connecting to it, allowing cellular phones to become increasingly smaller. The establishment of digital cellular networks paved the way for the smartphone because more data can be transferred more efficiently through this wireless network. The eventual proliferation of smartphones in the late 2000’s and consumer demands for faster data transfer speeds has spurred continued advancements in these networks (e.g., 3G and ultimately 4G LTE) (Kumar et al. 2010; Sood and Garg 2014).

The First Generation of Smartphones

While many think of now popular iPhones and Android devices as the first smartphones, these devices, actually debuted in 1992 with the IBM Simon. However, the infrastructure for digital cellular networks was not yet in place so using the device was quite clunky and considered too far ahead of its time (Woyke 2014). However, it had several features that have since become standards for smartphones, such as a touch screen, apps that outside developers could create that launched with icons, and the ability to send and receive written communications (faxes, emails, and pager messages). After the emergence of digital cellular networks, beginning with 2G, large cellular phone companies such as Nokia and Ericsson began manufacturing cellular phones with these kinds of “smart” features in the 1990s. Many of these manufacturers tried to combine the features of a personal digital assistant (PDA), which were fairly popular at the time, and a cellular phone (Campbell-Kelly et al. 2015). These phones were
marketed to and imagined for business elites who might need the convenience of one device for calendars, contacts, to-do lists, e-mail and web browsing, and phone calls all on the go. Several of these devices, such as the Palm Treo, had their own operating systems—considered the device’s “software core”—that, like the original Simon, allowed and encouraged outside developers to produce applications for the device (Daponte et al. 2013:3298). As smartphones evolved to become mobile computing devices that assumed roles associated with personal computers (e.g., web browsing), operating systems, which could power these activities, became increasingly critical features.

Smartphones like the BlackBerry, designed by Research in Motion, emerged in 2002 and were the first to use digital cellular networks to remain connected to the internet at all times. This was made possible through a data technology called general packet radio service, which breaks down data into small packets that can be moved more quickly through a network and also enabled carriers to charge subscribers for the amount of data they use rather than for the amount of time they spend online (Woyke 2014:21). The second iteration of the BlackBerry in the U.S. was a huge hit, especially among professionals, and featured typical PDA-style functionalities as well as a popular, always-on messaging service called Black Berry Messenger. Unlike many other smartphone manufacturers of the time, Research in Motion targeted enterprises, such as corporations and government agencies, rather than individual consumers alone, which meant that entire firms would subscribe to their services. This strategy was very successful and by 2009, BlackBerry controlled 20 percent of the global smartphone market (Woyke 2014:23).

Nokia, Ericsson, and BlackBerry dominated the first generation smartphone market. These phones were distinct from cellular phones in that they ran on operating systems, integrated third-party developed apps (often business oriented), and had internet connection capabilities.
These devices and the features they standardized paved the way for the second-generation smartphones of today.

From Mobile Telephony to Mobile Computing: Apple and Google

The second generation of smartphones moved the computer into the consumer’s pocket. These computing devices created an entirely new platform and marketplace on which health technologies could run, collect and analyze data, and be sold. Moreover, equipped with multiple sensors, these technologies made complex, passive tracking possible.

The iPhone, a smartphone manufactured by Apple and released in 2007, “radically” changed the smartphone market and reimagined what a smartphone could do, what it should look like, and what/who it should be for (Campbell-Kelly et al. 2015:719). Prior to the iPhone, Apple had achieved much financial success with the iPod, a portable music device, but worried that these devices would become obsolete with the rise of smartphones that included music players. While the iPhone’s predecessors were marketed towards business professionals and touted productivity tools such as email, web browsing, and schedule management, Apple wanted to make the smartphone an entertainment device for mass consumption (Woyke 2014). In addition to the PDA-style features common to other smartphones at the time, this device, which ran on an Apple-designed operating system (now called iOS), boasted a visual rather than physical keyboard, multi-touch screen, Wi-Fi connectivity, a music and video player, and an HTML browser that enabled completely different web experience. Thus, the iPhone was designed to be a consumer device that could seamlessly integrate into all aspects of life—both private and professional. While Apple did not initially allow third-party developers to create applications, by 2008, just one year after the launch of the iPhone, Apple introduced the App Store for this
purpose and was the first phone to build a store directly into the phone itself. By introducing third-party apps and in-phone virtual store in which to disseminate them, Apple created “its own self-sustaining ecosystem between consumers, developers, and the iPhone” (Woyke 2014:45).

In September 2008, Google launched its first smartphone, called the G1. Google took a very different approach from Apple: rather than manufacturing a phone itself, it created an open operating system, Android, which could be licensed and used by any smartphone manufacturer for free. While several first generation smartphones ran their own operating systems or partnered with a mobile OS developer, none of these operating systems could compete with the sophistication of Android (Woyke 2014). According to Campbell-Kelly and colleagues (2015:720), Google was motivated to join the smartphone market because while consumers were moving to smartphones to browse the web, “mobile phones were not particularly effective platforms for searching the Internet (and viewing Google’s ads).” Thus, to maintain the dominance of its core business, the search engine, Google needed to create a platform in which its products were central to mobile computing and mobile Internet navigation.

Working with phone manufacturing company HTC Corporation, Google’s G1 featured a large touchscreen, full physical keyboard, and trackball for navigation, and the device was designed to integrate and sync with google products such as the Gmail email service and calendars. Because Google’s web services already permeated consumer life, this integration was a critical feature of the device because it allowed users to begin a task on a computer, such as composing an email, and finish that task on the smartphone through “fluid, over-the-air data syncing” (Woyke 2014:51). This integration ensured that Google and its products could be central to mobile computing. Another unique feature was the virtual window-shade style of notification, now widely used on Android and iOS devices, that allows users to pull down a
“shade” from the top of the screen to view notifications. It was one of the first smartphones to integrate notifications into the device, now a critical feature for many wearable apps and other mobile health apps. Additionally, like Apple, Google created an in-phone marketplace, Android Market (now called Google Play), to encourage third-party developers to create apps to run on Android. Similar to Apple, Google used this feature to foster an ecosystem between the company, developers, and the consumer. Unlike Apple, which strictly polices the quality of apps listed in its store, Google marketplace is much more open because Android was an open source operating system.

Though both companies were motivated to develop a smartphone by concerns that these technologies would make their key products obsolete, Google took a fundamentally different approach to smartphones from Apple. While Apple created a “proprietary bundle of hardware and software,” Google created a platform (Campbell-Kelly et al. 2015:720). By making the platform free, Google installed their software on millions of devices, regardless of manufacturer, which allows them access to the data of millions of consumers, making it the most popular smartphone platform in the US today. Woyke (2014:68) thus describes Apple as using “services to increase the value of their devices,” while Google “commoditize[d] devices to achieve the widest distribution possible of their services.”

The Android operating system and the iPhone revolutionized the smartphone market, creating consumer devices that are always connected to the internet and with features for work and play. Both technologies were boons for these companies, making them the top two most valuable companies in the United States today. Their market success decimated many of the major first generation smartphone manufacturers, such as Nokia, Ericsson, Motorola, and BlackBerry. Because these new smartphones were designed to assume many of the roles of
computer devices, Apple and Google turned mobile telephony into mobile computing, thereby completely transforming consumer life.

Unlike the leading companies of the first generation of smartphones, Apple and Google designed their devices to seamlessly align (and perhaps even elide) professional and consumer tools, deepening consumer commitment to their companies and platforms. The iPhone and Android OS were designed to not only insert into but also take over a consumer’s entire life, such that consumers now use these phones for everything from alarm clocks and alarm systems to baby monitors, banking, social networking, health monitoring, purchasing, photography, note taking, and several other activities. Unlike other phones, Apple and Google designed products that completely subsumed consumer life, such that monitoring health and wellness, just like all other aspects of life, seems natural. In so doing, these companies—and often third party app developers—not only gained unprecedented access to every moment of consumer life, but were able to render all of these moments as data, which became central to their business models.

Sensors

Sensors have always been integral to a mobile phone’s functioning but since the emergence of the second generation smartphones, these sensors have proliferated and become increasingly sophisticated. This is in part because many of these sensors produce more complex data that can only be processed by contemporary advanced application processors. Thus, as processing technologies have advanced and sensing technologies have become more sophisticated, portable, and affordable, they are increasingly integrated into smartphones. Many of these sensors are central to how consumer health and wellness technologies function, as they often rely on phone sensor data to assess the user’s health and wellness.
Prior to the emergence of the smartphone, cellular phones included a variety of sensors, such as sensors for physical keypads and on and off switches. In addition, cellular phones housed acoustic sensors—microphones. These types of sensors are still crucial components of contemporary smartphones. However, a number of new sensors have been integrated into phones since the advent of the smartphone. Most contemporary smartphones now have touchscreens (in place of physical keypads) that involve capacitive sensing, which, in this case, refers to a sensor that detects the human body’s capacitance—ability to hold an electric charge—relative to that of the air to identify touch input. These touchscreens now often involve biometric sensors as well, such that a user’s fingerprints can unlock a device.

The remaining sensors can be categorized as: optical, thermal, magnetic and mechanical. Optical sensors include proximity, light, and camera sensors. Proximity sensors measure the proximity of an object, such as a user’s face, to the device and is typically used to assess the position of the phone relative to the user’s face or body during a call. Ambient light sensors measure the light in the environment to adjust screen brightness. Camera sensors include those used by the smartphone’s cameras that allow the device to take photographs. Thermal sensors are sensors that measure the device’s interior and exterior environment. These involve thermometers that measure the temperature of the device, often for battery and power management. Many smartphones now also include ambient temperature sensors to assess the temperature of the air and hygrometers that measure humidity, both of which can be used to assess the weather. Magnetic and mechanical sensors are crucial to consumer health and wellness technologies because they allow smartphones to measure motion. These include gravity sensors, accelerometers, gyroscopes, and barometers. Taken together, these sensors can measure a user’s movement with the device, including steps and speed, and determine the device’s location.
Gravity sensors detect motion, such as a shake, while gyroscopes sense rotation, like spins and turns. These types of sensors were integrated into these devices in part for game playing but also help measure how consumers move with these technologies. Magnetic sensors include magnetometer that senses positioning and location via magnetic fields. GPS chips, which allow smartphones to receive GPS signals, also locate the device. Barometers measure barometric pressure and work with GPS by delivering altitude data to more precisely locate the device.

Lastly, there are also a few sensors that are critical for wireless communication, such as those that allow smartphones to access Wi-Fi networks and Bluetooth connections. Many smartphones now include near field communication chips\textsuperscript{40} that enable mobile payments.\textsuperscript{41} As described above, Bluetooth sensors are critical in allowing devices such as wearables to communicate and sync data with smartphones, thereby giving the wearable a much needed mobile interface.

The motion sensors described above are likely the most commonly used sensors for assessing activity levels and movement, especially when combined with GPS and barometric sensing. However, all of these sensors enable these devices to monitor consumer behavior and activity continuously, allowing for constant data collection about consumer life that was not possible before the advent of the smartphone. These complex and continuous sensors have effected an incredible surveillance of consumer life. While many of the other sensors listed may not outwardly appear related to health, some consumer health and wellness technologies are using several of these sensors to assess consumers’ health. Ginger.io, for example, is a mental health mobile application that uses some of these sensors, such as on and off switching, combined with user activity on the device to assess mental health. Scully, Lee, Meyer et al. (2012) have used a smartphone’s camera sensors to create a photoplethysmography system that
assesses pulse and breathing rates as well as blood oxygen saturation using video and image capture. Similar optical sensors are already used in certain Fitbit activity trackers to measure heart rate. Kranz and colleagues (2012) have argued that near field communication technologies (which allows two devices to communicate with each other within 5cm distance apart) could be used to create a fitness application that would launch upon contact with certain devices and load previous fitness data to compare performances over time. Thermometers and skin response sensors are used in wearable activity trackers to assess skin temperature and sweat composition and light sensors are used to assess time of day.

EQUITY FINANCING: SOURCES, STAGES, LOGICS

As obviously critical as the technical developments described above are to the consumer health and wellness technologies this dissertation examines, equally crucial to their existence and operation is a particular kind of capital, called equity financing. As described below, equity financing refers to the advancement of capital in exchange for a share of ownership. In the context of consumer health technologies, equity financing usually takes two forms: angel investing and venture capital. One of the central empirical questions of this dissertation is to better understand what venture capital and angel financing are and how they work, on the ground, in the consumer health tech sector. Equity financing conditions the emergence and proliferation of consumer health and wellness technologies. This kind of capital involves particular individuals, policies, relationships, trajectories, and strategies. I contend that how equity financing is structured and rationalized fundamentally shape the development of consumer health and wellness technologies and the social, cultural, and economic work that they are imagined to perform, which I explore in depth Chapters 2 and 3.
Situating these technologies within the capital structures that make them possible can illuminate how value is understood to accrue in them and their futures. While some of the social scientific scholarship on these technologies consider how startups and corporations design these technologies (e.g., Schüll 2016) and others make claims about their data capitalization and profitability (e.g., Lupton 2016), none of these accounts have centered how equity financing is critically enmeshed with the production and circulation of these devices as well as their trajectories. Moreover, claims about profitability miss—and cannot even account for—the incredible routinization and pervasiveness of financial failure in this sector. Some of the equity-financed companies that develop these technologies, such as Google and Fitbit, are collectively worth hundreds of billions of dollars. However, many early stage consumer health and wellness companies are not (yet) profitable ventures and, in fact, most will fail. As a result of this uncertainty that pervades the startup sector, these companies are considered incredibly risky investments by the financial sector.

As I will describe, equity financing has been constructed and positioned by specific policy and the finance sector as uniquely structured to manage these risks and discern the success from within a sea of failure. This form of financing is future oriented, as investors advance capital to companies in the very early stages of their development often based on the technologies they plan to or are just beginning to develop. If these companies return any investment made, it may be years in the future. In this context, the futures that these startups envision and assemble become critical to how investors assess their value and likelihood for success. For investors, startup financing is an invitation to envision and build the future in the present—to lay the groundwork for their own long-term capital gains and, in the process, gamble on everyone else’s future (sometimes with everyone else’s capital). Speculation is thus always
already *built into* the financing strategies and financing relationships of the consumer health and wellness technology sector and is reinforced by neoliberal regulatory reforms that have made this kind of capital available in the first place. In what follows, I first explore what equity financing, angel investing, and venture capital are; how angel investing and venture capital work and what they are designed to do; and the political-economic conditions that make equity financing possible.

*What is Equity Financing?*

Equity financing denotes the advancement of capital to a company for business activities in exchange for equity, meaning a share of ownership, in that company. The two dominant forms of equity financing for consumer health and wellness technology startups are angel investments and venture capital. In both forms of financing, investors typically provide capital to a private company, meaning a company whose securities (stock)\(^{43}\) are not (yet) traded on a public market (e.g., the NASDAQ Stock Market) in exchange for a portion of ownership (equity) in the company, typically\(^{44}\) in the form of preferred\(^{45}\) stock. Because these companies are usually not yet profitable in their early stages, these investments are organized around long-term\(^{46}\) capital gains, where returns on the investment may materialize several years later, if at all. These returns, if realized, are made upon what is known as an ‘exit,’ wherein investors liquidate their share in a company by either selling their equity to another investor or company, or through an initial public offering (IPO) where the company becomes publicly traded.

New ventures are considered highly risky for investors in part because their success or failure can be hard to predict. These startups also do not typically have tangible assets (for collateral) and early stage companies’ performance is not often easy to assess because they are new ventures (Keuschnigg and Nielsen 2002). Moreover, startups are expected to lose money for
many years before achieving profitability, if ever. These ventures may also be characterized by “uncertainty and information asymmetries,” where the entrepreneur and the investor may not have equal information and understanding of the product or the entrepreneur hides information from the investor (Dehlen et al. 2014; Gompers and Lerner 2001:154). Additionally, an entrepreneur may be passionate about “strategies, research, or projects that have high personal return but low [or unknown] expected monetary payoffs to shareholders” (2001:155).

Investments made in these new ventures are illiquid, meaning it cannot be converted into cash and cannot be easily sold. As a result of these risks, it can be difficult to foresee the company’s outcomes and costs to determine how the firm should be financed (Gompers and Lerner 2001). Startups seek financing from venture capitalists in part because venture capital is considered uniquely structured to mitigate these risks and are therefore willing to advance capital where other financial intermediaries, such as a bank, would not.

Startups typically seek equity financing early on in their development, and these financiers are often among the first investors other than friends and family that an entrepreneur will seek. As I will show, because equity financiers are involved at such an early stage, these financiers can have significant influence over the development of the company and its products. Moreover, because they invest early, these investors advance capital before the company has generated any profit (and will likely never generate any profit). Thus, equity financing is highly speculative and future-oriented, as it is organized around long-term (and unlikely) capital gains. I will now describe the sources and stages of capital for equity financing, and discuss the history and structure of venture capital financing. Lastly, I consider the how investors and economists justify and rationalize the routinization of failure in equity financing.
Sources & Stages of Capital

As with many emerging consumer technology companies, angel investors and venture capitalists are the main sources of equity financing for consumer health and wellness technology startups. Within the category of venture capitalists, there are corporate venture capitalists and institutional venture capitalists. As indicated in Figure 2.2, a startup may seek capital from one or more of these sources throughout the company’s life. Figure 2.2 illustrates how these investors are differentiated by the sources of their capital, the motivations for their investments, and the stages at which they invest. I will describe each in turn below.

![Diagram of Stages and Sources of Capital]

Figure 2.2: Stages and Sources of Capital

Angel Investors

What distinguishes an angel investor from other investors are the source of the capital that they invest and the stages of financing in which they are involved. Angel investors (also
known as business angels) differ significantly from venture capital investors. First, angel investors, which the SEC designates as “accredited investors,” use their own, personal capital to invest into companies. In some cases, angel investors group together to pool their resources for investment, but the pooled funds are still sourced from each group member’s personal wealth ((Kerr, Lerner, and Schoar 2013). According to Metrick and Yasuda (2010:4), “since they can keep all the returns to on their labor, [angels] have a correspondingly lower cost of capital [than VCs] and can invest in deals that would not work for a VC.” Angels tend to invest smaller amounts of capital in many ventures, despite investing roughly the same magnitude as VCs. As Figure 2.2 indicates, angel investors typically invest in companies in their very early stages, usually prior to the involvement of a venture capitalist or a venture capital firm (Venugopal and Yerramilli 2016). According to De Clercq and colleagues (2006), angels, some of whom are entrepreneurs themselves, tend to invest in sectors in which they have expertise.

Beyond providing capital, entrepreneurs seek angel investments because they provide mentorship, counsel, access to their network, and can make introductions to venture capital firms for future funding. Angels are typically the first form of equity investor that an entrepreneur will seek funds from, called the seed stage, usually after seeking funds from friends and family (pre-seed stage). Thus, like other forms of equity financing, angel investors provide much more than capital to a startup. They provide critical resources at an early stage and can play a significant role in the design and development of the product and the structure of the company. Moreover, by connecting startups with other sources of capital for later stage funding, angels can fundamentally shape the company’s future. Because angels invest their own, personal capital at the earliest stages of a company’s life, they take on considerable risk in making these highly speculative investments. These new companies often have few assets, a limited track record, and
are years away from potential (if any) profit. Thus, angel financiers and investors that advance capital in these early stages are financing these companies based on their vision for their company, its products, and society.

Entrepreneurs form relationships with potential angel investors in a variety of contexts to secure angel financing. They may connect through personal or professional networks, such as a referral from a friend or through a university group; at pitching and other networking events; or through cold contact via the internet or social networks, such as AngeList (De Clercq et al. 2006). Entrepreneurs usually provide an informal pitch to angel investors before securing an investment (De Clercq et al. 2006). According to the Angel Resource Institute’s Halo Report (2015:6), the average size of the angel round in the third quarter of 2015 was $750K, with a median of $1.41M (up from $500K in the second quarter of 2015 with a median of $735K). Because angels invest so early on in a company, they may take up to a 40% share of ownership in the company in exchange for their personal capital, though this share might be diluted in future venture capital rounds (Headapohl 2006). A typical exit for an angel investor is through a trade sale, in which they sell their equity in a company to another investor or company.

**Venture Capital: Corporate Venture Capitalists (CVCs)**

The other major form of equity financing that a startup in the consumer health and wellness technology sector may seek is venture capital, which can be further differentiated into two types: corporate venture capital (CVC) which I describe here, and institutional venture capitalists (VCs) which I discuss in the following section. As indicated in Figure 2.2, what distinguishes CVC from other forms of equity finance is that CVCs advance capital from a parent corporation into entrepreneurial ventures in exchange for equity in that venture. For
example, consumer and enterprise technology companies like Google, the Samsung Electronics Company, Ltd, and Cisco Systems, Inc.; health insurance providers and managed care organizations, like Kaiser Permanente; and pharmaceutical and biotech companies, such as Johnson and Johnson, Inc., have very active corporate venture capital arms.

These corporations invest in startups because, like angels and VCs, CVCs are interested in equity growth in the companies that they invest in. However they are “primar[ily] interested in securing strategic benefits for,” adding value to, and improving the competitiveness of their parent company (De Clercq et al. 2006:94; Lantz et al. 2011). They invest in order to “exploit their existing capabilities” and expand their existing business, perhaps by developing complementary products that might “stimulate the demand” for the product they already developed (Park and Steensma 2012:3). They may also invest in order to source new and innovative products and/or enter a new market, and to identify and acquire new ventures developing promising technologies that would otherwise benefit the firm (Park and Steensma 2012:3). Unlike institutional VCs (described below), CVCs are often interested in so-called strategic objectives when making investments, such as providing a window into new markets and emerging technologies and considering new business directions (Lantz et al. 2011; Souitaris and Zerbinati 2014). As a result, CVCs often look for startups that are a strategic fit for the parent company and which “have synergies with the corporation’s own businesses” (Lantz, Sahut, and Teulon 2011:370).

A startup would consider pursuing CVC funding because they have considerable assets and sector-specific resources that institutional VCs might not have. For example, securing CVC investment can provide the startup with access to “valuable complementary assets from their corporate investors, including expertise and infrastructure for product development,
manufacturing, legal, distribution, marketing, sales, and customer service activities” (Park and Steensma 2012:3). CVCs may also provide startups with access to target customers and distribution channels as well, which can help the startup scale their products and drive revenue (Hansch 2016). According to Lantz, Sahut, and Teulon (2011), startups can also gain credibility and legitimacy from a CVC and benefit from access to product distribution networks, research and development support, entrepreneurial networks for future financing, and technical and market expertise. Such resources are not often available to new ventures and can be helpful resources for stimulating commercialization. Corporate Venture Capitalists, such as Kaiser Permanente Ventures and Samsung Ventures, are quite active in the consumer health and wellness technology sector. By advancing capital to consumer health and wellness technology startups, these companies lend their considerable corporate wealth and network to advance a particular vision of the future. These companies have already laid considerable groundwork of their own, and startups that receive capital from these companies can draw from and rely on the company’s established markets and existing infrastructure to advance their products. Thus, the startup’s claims on the future can become materialized through the significant resources the company can mobilize to advance this vision.

However, because the CVC’s primary interest is to add value to its parent company, the startup and CVC’s interests are not always aligned, which can sometimes create conflict. For example, the parent company may be developing competing products to that of the new venture, and may even “expropriate IP created by new ventures” (Park and Steensma 2012:4) and relationships with a CVC may affect the kinds of partnerships that would be available to the new venture in the future. In addition, though the CVC can provide the startup with complementary
assets, they do not provide as much oversight or mentorship that is typical of institutional venture capital firms.

While a CVC might provide capital in the seed stage of a new venture, they typically invest in in the later stages, such as the start-up and expansion stages (see Figure 2.2). This is because early stage startup’s “products and services are not clearly defined and can change radically over time, which could undercut the strategic benefits available to a CVC parent from its venture investment” (Masulis and Nahata 2009:605). As with other sources of equity financing, an entrepreneur may connect with CVCs in multiple ways: entrepreneurs may form relationships with CVCs through formal and informal networking, through a referral within the CVCs parent corporation, or through an introduction made by an angel investor or VC contact (Souitaris and Zerbinati 2014, De Clercq et al. 2006). If a CVC is interested in financing a startup, the startup may be asked to present a formal pitch.

There are a variety of exit strategies for a startup with CVC financing. As with other equity financiers, a startup with CVC financing may be sold through a trade sale, meaning the shares are sold to a single buyer, or the startup may hold an initial public offering through which it becomes a publicly traded company. However, unlike angels and institutional venture capitalists, a CVC may acquire startups it invests in, such that the startup, its products, and assets become part of the parent company.

**Venture Capital: Institutional Venture Capitalists (VCs)**

Institutional venture capitalists, also known as VCs, are a second type of venture capital financing and are perhaps the most well-known source of funding for startups. What distinguishes VCs from other equity financiers is the source of their capital. As I have described,
angel investors are typically high net worth individuals who invest their own capital and CVCs invest capital from parent corporations. Venture capitalists, on the other hand, raise capital for their fund from a variety of sources known as limited partners. They are therefore classified as “financial intermediaries,” a key characteristic of a venture capitalist (Metrick and Yasuda 2010:3). Currently, limited partners tend to be pension funds, university endowments, charitable foundations, wealthy families, large corporations, and insurance companies. VCs raise anywhere from a few million to over a billion dollars from a combination of these sources for their funds, which are generally designed to last 7-10 years. VC firms in the U.S. collectively raised $34B in 2014 with an average fund size of $134M and a median fund size of $25M (PitchBook, Inc. 2015).

A History of Venture Capital: The Policies and Reforms that Condition its Possibility

Venture capital financing has been made possible for high risk investments through a series of neoliberal economic policies and reforms. In what follows, I describe the history of venture capital, paying particular attention to how federal regulations, tax reforms, and other policies have promoted the significant growth of the venture capital industry since the 1940s.

Venture capital financing began in the 1940s and advanced capital to high-risk emerging (typically technology) companies with uncertain futures and few assets (see above for more detail on risks), with the potential for long-term capital gains as opposed to more immediate gains (Gompers and Lerner 2001). These firms were financed through closed-end mutual funds, meaning that investors could buy and sell shares in the fund, similar to stock. However, this new form of investing was not well understood by those whose money was invested in these funds.
(through its publicly traded structure), and institutional investors did not typically invest in these early firms as a result of these risks.

In the 1950s the limited partnership model, which is the most common structure of venture capital funds today, began to emerge. These firms raised investment funds from high net-worth individuals rather than through selling shares. These partnerships were designed to span a predetermined, limited amount of time (typically ten years), as opposed to the hypothetical indefinite lifespan of the publicly traded structure. By raising capital this way, "partnerships were exempt from securities regulations, including the exacting disclosure requirements of the Investment Company Act of 1940" (Gompers and Lerner 2001:147). This exemption was particularly appealing for emerging firms. However, this financing structure was still the minority model for VC funds in the 1960s and 1970s.

This changed dramatically in 1979, when the U.S. Department of Labor clarified the Employee Retirement Income Securities (ERISA) Act of 1974, which in part governed how pensions could be invested, and allowed up to 10% of funds to be invested in high risk assets like venture capital. As a result, pensions funds, which could now become limited partners, became a significant source of capital for venture capitalists, such that by the end of the 1980s, pension funds were contributing over $4B to VC funds up from a few hundred million in the late 1970s (Gompers 1994).

In addition to ERISA reforms, tax reforms led to an explosion of venture capital in the 1980s and into the present. The 1978 Revenue Act reduced the tax rate applied to capital gains significantly, which resulted in a “substantial ‘unlocking’…of previously accrued but unrealized capital gains” (U.S. Office of the Secretary of the TreasuryU.S. Office of Tax Analysis 1985:i). These reforms also allowed a larger portion of $long-term$ of capital gains, a major source of
income for VC funds, to be tax deductible (Briner 1979). In addition, carried interest (a share of the profit\textsuperscript{54} that investment fund managers receive upon the sale or exchange of an asset) is taxed currently as a capital gain and not as income, meaning it is generally taxed at a lower rate. These tax reforms also spurred the development of angel investing and corporate venture capital.

Additionally, Armour and Cumming (2006) argue that liberal personal bankruptcy laws make it easier for entrepreneurs to take on the personal financial risk and financial precariousness of the startup sector because they can more easily financially survive a failed venture. Additionally, “a lower differential between the personal tax rate and the capital gains tax rate” can also encourage otherwise employed individuals to pursue entrepreneurship for the potential financial gain this tax favorability provides (Da Rin, Nicodano, and Sembenelli 2006:1700).

Michelacci and Suarez (2004:459) contend that allowing early stage companies (rather than only mature companies) to be listed on stock exchanges\textsuperscript{55} can free up the limited supply of venture capitalists’ expertise and counsel—“informed capital”—for other ventures because the VCs have exited that venture. Additionally, low fees associated with issuing new securities for publicly traded companies (flotation costs), allow younger companies to go public earlier, which also frees up VCs informed capital (Da Rin et al. 2006).

\textit{The Structure & Phases of VC Financing}

Unlike other investors, a VC’s primary goal and “sole objective is to realize capital gains through the sale of venture equity at an exit event such as an IPO or acquisition” (Park and Steensma 2012:3). Because VCs are financial intermediaries who are seeking to maximize the
returns for their limited partners, this fundamentally affects the financial decisions a VC makes and uniquely characterizes venture capital investing (Metrick and Yasuda 2010).

As demonstrated in Figure 2.2, equity financing is typically staged, meaning that startups seek capital in stages or rounds. Venture capitalists can provide capital at all stages of a startup’s life. These stages are organized around the amount of capital provided and often firms are themselves are organized around these stages. Thus, while some firms specialize in providing capital in a company’s early stages, others focus on later-stage companies; this requires different resources because a company’s product(s) will be at a different stage of development throughout the startup financing trajectory. However, some firms provide capital at all stages.

Venture capital firms may also specialize by sector, which often becomes evident from the kinds of companies in their portfolio. In the context of consumer health and wellness technologies, while some VC firms involved in this arena specialize in the healthcare sector or the healthcare internet technology (IT) sector, others specialize in consumer or enterprise software solutions, while still others specialize in consumer or enterprise hardware and IOT (internet of things) technologies and platforms.

Venture capital is a critical financing mechanism for U.S. startups, including consumer health and wellness companies. Startups seek financing from VCs because, as with other equity financiers, venture capitalists offer a startup far more than capital, and are therefore considered “value-added investors” (Amornsiripanitch, Gompers, and Xuan 2016; Fitza, Matusik, and Mosakowski 2009:389). As detailed below, VCs often will occupy seats on the startup’s board of directors, and provide advice and mentorship, including assistance with financial strategy and management; and help with professional development. They also provide access to networks, including connecting and mediating relationships between startups and other investors for future
investments, and increase a startup’s credibility and legitimacy, especially to other investors (Fitza, Matusik, and Mosakowski 2009; De Clercq et al. 2006).

Potential investors’ relationships with startups are often highly choreographed, as indicated in Figure 2.3 (below), in part because of the risky nature of investing in startups. Thus, investors assess whether or not to invest in a startup through a series of phases through which they determine the company’s potential for growth and long-term capital gains.

There are a variety of formal and informal mechanisms through which investors and startups connect. These include: referrals from personal and professional networks, networking events, introductions made by financiers who have already invested or are interested in investing in the startup, cold contacting by the investor or the startup, or connections facilitated by participation in an accelerator or incubator program (which help a startup jumpstart their product
If a firm or investor considers financing a company, they will assess its potential to produce long-term capital gains upon exit, often using proprietary algorithms, and the company may be invited to pitch their products to the firm. If the firm decides to proceed, they will perform extensive due diligence on the startup team, product(s), business plan, cash flow, expenses and spending, salaries, market, legal issues like intellectual property protections and lawsuits, and the entrepreneurs involved to assess the viability of the company and its plan (Camp 2002).

If the company passes the due diligence phase, the firm will move forward with the investment by structuring the deal. Critically this involves negotiating the startup’s valuation—determining how much it is worth in order to price the equity securities the firm will be purchasing. The VC firm uses a variety of mathematical techniques to estimate the startups valuation, often based on “expectations of the likely value of the venture at the time the VC anticipates exiting”—its future value (De Clercq et al. 2006:99). Particularly in a startup’s early stages, this appraisal is often based not only on what the company has developed but their potential and promise—the vision of the future that the company hopes to build. As De Clercq and colleagues (2006:99) argue, for early stage companies, “the actual equity received for a given level of investment is much more likely to be determined by prevailing norms than any actual calculation of realistically expected future cash flows” and can therefore be highly speculative.

As noted above, because investors are often highly involved in the companies that they finance and provide more than capital, when structuring a deal with a startup they often also negotiate the amount of control the firm will have over administrative management of the company. This can include: control the investment firm can have over the composition of the
board of directors, the number of voting and non-voting board members the firm is allowed to involve, the kinds of company spending that will require VC approvals, employment contracts, forfeiture provisions, and “the mechanism given to the VC to force a future exit event” (De Clercq et al. 2006:99). The final deal negotiated is referred to as the term sheet, and may include potential exit strategies as well. Typical exit strategies for a venture capitalist are trade sale of their equity to a company or another investor or seeing the startup through to an IPO.

*How Venture Capital Works Without Working: Wild Success, Routinized Failure, and Equity Financing as Risk Management*

Because equity financing involves high-risk investments, economists consider it uniquely structured to manage risk. Equity financiers, particularly VCs and CVCs, engage in specific practices that are designed to mitigate financial risk to the firm. By engaging in extensive due diligence, CVCs and VCs vet potential entrepreneurs, their products, teams, and markets substantially before providing capital. In addition, investors are heavily involved in the companies in which they invest, employing capital provision strategies and direct management techniques to best ensure the success of their investments. Capital provision strategies structure how funds are advanced to the startup to protect the investment. One such strategy is staging investment: Providing capital in stages rather than all at once allows investors to risk less capital at each stage and maintain a “tight leash” on portfolio companies to “reduce losses from bad decisions” because they can tie financing to the startups’ ability to achieve certain milestones (Gompers and Lerner 2001:155; Kerr, Nanda, and Rhodes-Kropf 2014). If a startup is underperforming and fails to meet their milestones, the firm can cut their losses by choosing against reinvestment in future rounds. (Kerr, Nanda, and Rhodes-Kropf 2014). Another capital
provision strategy is to syndicate investments, in which investors may partner with other firms (known as syndication) for a funding round, which allows them to spread the risk of the investment across multiple firms. Lastly, a portion of employees’ salaries or wages might be paid in equity or options in the company to ensure that employees’ interests are aligned with the success of the firm, and these options often are structured to vest over many years to keep employees from leaving the company immediately after vesting.

Additionally, investors are often directly involved with the startup’s decision-making through board membership and reporting tactics. VCs often negotiate some control over the composition of the company’s board of directors when structuring the deal, usually occupying at least one seat, which sometimes allows the investors to replace the CEO (and others in the company) if their performance does not meet certain targets. Additionally, the VC firm may require certain spending decisions be approved by the firm beforehand to monitor expenditures. The investor may set particular targets for the company to achieve within the funding period and require the startup to report on its progress regularly. Investors are also often available for and sometimes expect to be consulted for guidance on spending, employee contracts, marketing, and other strategic decisions.

Crucially, in the (usually highly likely) event that a portfolio company performs poorly after the investment, the company and/or its assets, such as technological equipment, patents and other intellectual property, and real estate will likely be sold off to buyers. However, because investors’ equity is typically in the form of preferred stock (see Note 51), investors are paid first, before founders and employees, who are paid back in common stock. Thus, investors are often able to recuperate much of their investment even when companies fail. Moreover, failure is dispersed across limited partners, funds, firms, and companies. VCs do not risk any of their own
capital in financing new ventures and often highly compensated through fees regardless of whether or not their ventures succeed (Mulcahy 2014). Others argue that the careful choreography of due diligence and the phases of startup-investor relations allow investors to partner with entrepreneurs who may eventually found valuable companies. Because an investor’s relationship with an entrepreneur may extend beyond one venture, these practices allow the firm to screen the entrepreneur and their team for future partnerships. They build the future by building relationships that may entail initial failure. Lastly, economists argue that the profits generated from the few wild successes more than make up for and justify the ubiquity of failures. The highly speculative nature of equity financing is thus rationalized through these various techniques that spread the financial risk across multiple actors and multiple time periods.

But perhaps more importantly, economists consider these strategies critical to enabling a highly experimental approach to innovation, as they allow investors test out—and begin assembling—bold visions of the future without bearing significant financial risk. While equity financing produces a few famed wild successes, such as Google and Facebook, it largely produces wild failure. The vast majority of ventures that firms pursue will end in failure, such that the firm takes majority losses. Indeed, the vast majority of investments return less than invested, such that “the modal outcome of a venture capital investment is complete failure” (Nanda and Rhodes-Kropf 2013, emphasis added). However, as billionaire Vinod Khlosa argues, “Our willingness to fail gives us the ability and opportunity to succeed where others may fear to tread” (quoted in Nanda and Rhodes-Kropf 2013:403). In his and others’ view, this level of complete failure is constructed as complementary and necessary to success. In this context, failure becomes not only part and parcel of success, but also viewed in and of itself as successful.
Economists argue that, given the inherent uncertainty of startup trajectories, equity financiers need to have the freedom to experiment on what visions of the future will actually stick, because this freedom is crucial to innovation. The types of risk management strategies described above uniquely position venture capital financing as essential for innovation and what they call “creative destruction,” or new products and markets that revolutionize economic structure by challenging and replacing existing companies, thereby moving capitalism forward.63 Moreover, Keuschnigg and Nielson (2002) argue that venture capitalists possess a unique kind of expertise that makes them essential to innovation:

In face of this existential risk, entrepreneurial activity can emerge only if financial intermediation [of venture capitalists] provides sufficient insurance. A fixed number N of agents are endowed with unique skills and knowhow that enables them, apart from possibly becoming entrepreneurs or workers, to finance and advise start-up firms (P.178)

However, this freedom is made possible and maintained through neoliberal reforms (described above) that make the stakes of failure low and dispersed, while simultaneously making the benefits of success potentially wild. Thus, equity financing works without working because failure is routinized and justified by the speculation and uncertainty that is always already built into equity financing. In this context, equity financiers always win.

CONCLUSIONS

In this chapter, I have explored the technical and economic conditions that have made wearables and consumer health and wellness technologies thinkable and possible. While I have distinguished these conditions, they have not only evolved together but are co-constituted; the technical developments that gave rise to increasingly portable computers are situated within and have simultaneously spurred the growth of the equity finance industry. In turn, increasing opportunities for equity investments and the growth of the equity finance industry has greatly
contributed to the development and proliferation of portable consumer electronics and expanded the possibility for ubiquitous tracking. Moreover, I have shown how federal regulations and deregulations in both the financial sector and in networking technology are critically constitutive of these developments.

This chapter began with how imperatives for increasing portability and miniaturization in computing have driven developments in wearable and communication technology. I trace key advances in power and circuitry, as well as in network technology, that made it possible to progressively miniaturize devices. I situate these developments within the landscape of federal communication policy that incrementally made military technologies, such as GPS and portions of radio spectrum available for commercial use and development. I then trace the developments in cellular networks and cellular technology that eventually gave rise to the contemporary smartphone. I show how these devices transformed mobile telephony to mobile computing and were designed to subsume consumer life. I lastly consider the myriad sensors that critically enable increasingly tracked consumer life, which have been crucial to the development of consumer health and wellness technologies.

In the second half of the chapter, I explore the structure of equity financing and how, in the face of incredible uncertainty around startup trajectories, speculation is always already built into consumer health and wellness technologies. Built on long-term capital gains, this form of financing experiments on various visions of the future and assembles those visions in the present. By describing what equity financing is and how it works, as well as the logics through which it makes itself necessary, I show how the structure and strategies of equity financing make experimentation possible. These tests—what they call experimentation—are learning
experiences for both parties and risk management techniques keeps the costs of experimentation low.

Given the pervasiveness of failure, this model understood to be successful—failure is viewed as in of itself success. Economists explain away this seeming paradox by arguing that the pervasiveness of failure indicates that success is always already unpredictable. For example, Nanda and Rhodes-Kropf (2013:403) argue, “failure is central to the venture capital investment model, as extreme success and greater failure may go hand-in-hand in a world where the outcome of novel technologies or business models is impossible to know ex ante.” Rather than demonstrating the inherent inadequacy of equity financing to predict the future and predict success, these economists rationalize experimentation by arguing that success is unknowable without experimentation. In the face of this inherent uncertainty, economists argue that the risk management strategies that characterize equity finance allow for crucial experimentation to manage this unpredictability.

However, I argue that in the political economic and legislative conditions that make venture capital possible, pervasive failure is enabled and becomes normalized. Neoliberal economic policies that I described in this chapter—such as banking deregulations that increase the availability of debt financing, low capital gains taxes (especially applied to carried interest) increase the amount of returns reaped from the few wild successes, liberal personal bankruptcy laws that make entrepreneurs’ post-failure recoveries possible, ERISA and pension reforms that made billions of dollars available for investments without disclosure requirements, and low corporate income tax rates—all work together to make the stakes of failure low for these particular actors. Innovation runs on failure because failure runs on these neoliberal policies that are structured to make this kind of failure acceptable and necessary to success. These neoliberal
policies also condition the possibility of “wild” success—success can be wild for these firms through the same policies that make failure acceptable and allow VCs to reap incredible capital from their financial experiments.

In this logic, the pervasiveness of failure becomes indicative of high levels of uncertainty around venture success rather than inadequacy of venture capital to predict the future. But what is considered successful, who wins, and what winning (and failing) produces are structured by these neoliberal policy reforms, rather than the invisible hand of the market. Because economists consider equity financiers critical to advancing capitalistic economies by fostering innovation through experimentation, the neoliberal reforms that make equity financing possible allow investors to make the stakes of failure low and success wild in the first place. This allows investors to win either way because they are always already indispensable to innovation. The speculative promise of building the future by testing ventures in the present is thus built into the trajectories and financing of consumer health and wellness technologies. In these ways, venture capital is allowed to work without working, because neoliberalism makes its failures acceptable, minimal, justifiable, and necessary. In the next chapter, I explore how venture capital-financed consumer health and wellness technologies work through this idea of experimentation.
CHAPTER 3: WORKING WITHOUT WORKING: ASSEMBLING THE DIGITAL AND ECONOMIC INFRASTRUCTURES OF THE FUTURE

A startup is the largest group of people you can convince of a plan to build a different future. A new company’s most important strength is new thinking.”

- Peter Thiel, Venture Capitalist, PayPal Co-Founder

“The Challenge of the Future,” in Zero to One: Notes on Startups, or How to Build the Future

INTRODUCTION

Venture capitalists invest in a startup based not only on what it has already achieved, but also by speculating, evaluating, and betting on what it might be able to achieve in the future—the startup and its products’ potential. In his guide to startups, PayPal co-founder and venture capitalist magnate, Peter Thiel (2014:10) writes with Blake Masters that startups’ power lies in their ability to “build a different future.” Thiel made his billions at PayPal and currently leads one of Silicon Valley’s most prestigious venture capital firms. He considers “new thinking,” a feature unique to startups, to be critical to producing what he calls “vertical progress,” meaning...
“doing new things [that]… nobody else has ever done”—a different future (Thiel 2014:6-7). As my participants told me, when venture capitalists evaluate a startup, they look for this potential for new thinking. In a startup’s early stages, venture capitalists are therefore not only interested in the products being imagined or developed in and of themselves, but also how these products represent, make possible, and set in motion a particular vision of the future.

Claims about future-building are pervasive in Silicon Valley and they organize venture capital raising and startup thinking. For example, in the website image from the “why Fitbit” section of its site (Figure 3.1), leading wearable vendor Fitbit deploys its own history to justify the excitement around its devices, arguing that the company has “a history of inventing the future”:

We were the first in the category, the first to introduce automatic, wireless syncing, and the first to provide an open API. Our algorithms have been the benchmark. Even now, when we’ve got industry-leading battery life and the thinnest, lightest GPS + heart rate device on the shelf—we’re still just getting started.

This image embodies Theil’s startup principles: the company argues that it is uniquely able to “invent the future,” marshalling its own products as evidence of its “new thinking” and future-building experience. Fitbit claims that in the nine years since its inception in 2007, it has been revolutionary and visionary, inviting consumers, developers, and investors to consider what they have the capacity to achieve in the future, and what our world will (and already does) look like with Fitbit at the helm. This piece of marketing is meant to communicate both what Fitbit has achieved as well its potential. These visionary companies claim to be envisioning and inventing a new future that only a startup could have imagined. They claim to have anticipated consumers’ needs years in advance and convinced them that this is the future they have always already wanted; the company is bragging about its foresightedness.
In this chapter, I therefore foreground the work these technologies perform in the present—which I call groundwork—to animate, assemble, and make inevitable the future that they are inventing. In so doing, I found that investors and founders make consumer health and wellness technologies valuable in the present because they lay the groundwork—the digital and economic infrastructure—for a future that only they can imagine. Even more significantly, by financing or considering investments in consumer-facing health and wellness technology companies in the present, these investors have already set in motion the future they anticipate. These infrastructures promise to invent and enable a future in which these technologies are embedded as mundane and daily features of all consumers’ lives, the groundwork for which is already underway. Even if those companies themselves fail, the economic and digital infrastructures are already being assembled through investor excitement about these futures. These futures animate and organize discussions of their potential impact and current value.

UNPACKING THE WEARABLE PARADOX

How does the infrastructural and future-building work that consumer health and wellness technologies perform and the futures they make possible figure into the value they accrue in the present? I was led to this question because many leading consumer health and wellness technologies do not actually work well, despite their high valuations and market capitalizations. I call this the wearable paradox. Throughout my fieldwork, investors and founders actively acknowledged the significant shortcomings of contemporary health and wellness devices and yet continued to see much value and promise in these technologies. Some of these technology companies have achieved enormous financial success and have inspired much investor excitement, despite these seeming limitations. I contend that to reconcile this paradox, it is crucial to examine the work these technologies perform in service of a particular future—to
consider how these technologies ‘work without working.’ I use the economic success of Fitbit, which epitomizes this apparent paradox, as a way into the future-building efforts being performed in the present.

At first glance, activity trackers produced by Fitbit appear to be ubiquitous: the company is the leading wearable vendor worldwide, with 22.2% of the market share in the 3rd quarter of 2015 (2015c). This popularity has earned Fitbit significant financial success, with an initial market capitalization of over $5B when the company held its initial public offering in June 2015.66 However, several of my participants have mentioned that Fitbit’s users do not consistently use its devices and apps, citing anywhere from 3-6 months of use for most consumers. Rock Health, a Bay Area investment fund focusing on health and healthcare companies, has estimated that “only half of Fitbit's nearly 20 million registered users were still active as of the first quarter of 2015,” according to the company’s Securities and Exchange Commission S-1 filings67 before its initial public offering (Gandhi 2015; Jesdanun 2015). This is consistent with findings from Endeavor Partners, a consulting firm, which reported in 2014 that half of Americans who have purchased an activity tracker have abandoned their devices and one third abandon these devices after six months (Ledger and McCaffrey 2014). According to the investors and founders I interviewed, consumers stop using Fitbit activity trackers and similar devices because these products are not accurate. Indeed, several class action lawsuits have been filed against Fitbit due to claims of heart rate and sleep-tracking inaccuracies. In addition, my participants reported that the data these devices produce are often “in-actionable,” because they do not point to concrete actions that the user can take to improve their health and wellness, leading to high device abandonment. Given these shortcomings, why is Fitbit so highly valued?
In the previous chapter, I explored how most equity-financed ventures are expected to fail, which economists claim investors to experiment in order to innovate. Rather than stymieing excitement, these failures and shortcomings are constructed as opportunities to learn more about markets, consumer habits and preferences, and reiterate. However, I argue that the futures that so-called “early stage” technologies incrementally make possible sustains investors’ patience and excitement. To investors, companies like Fitbit are building the infrastructures and setting the standards for those futures in the present and, as a result, the future value of these infrastructures is brought to bear on these companies’ current value.

In what follows, I first describe how these technologies’ ‘work without working’ by exploring the work that they do, even when they fail. I illustrate how these technologies build value by creating the infrastructure through which it becomes possible to capture consumer life constantly through wearables and mobile apps, providing a portal for companies to access these health and wellness data that did not heretofore exist. This digital infrastructure being assembled defines what these technologies will do—the role they will play in consumers’ lives and the kinds of lives they will make possible—once they emerge from the “early stages” of their development. I then describe how these technologies create imperatives to integrate data across platforms, companies, and technologies and standards to do so. These standards lay the groundwork for an increasingly connected, tracked future.

HOW HEALTH TECHNOLOGIES WORK WITHOUT WORKING

Despite likely failure, my participants spoke of health and wellness technologies, particularly popular wearable technologies, as having inevitable economic success and revolutionary potential. How do we reconcile this perception of the inevitability of success with the pervasive failures of startups? For the founders and investors I interviewed, the inaccuracies
of wearable technologies and the failure of so many health startups does not contradict the economic success of a few companies, such as Fitbit and Jawbone—the failure and success are of a piece. If they can make the success of this class of technologies feel inevitable, the ideas and the market survive, even if crowded technologies crumble along the way. All the companies that fail allow the winners to prevail, and allow the type of life and data that these winners make possible to prevail. All the imperfections and inaccuracies are inconsequential to these actors because they are investing in the long game, which is established and furthered by these early-stage companies.

In the following sections, I argue that by framing the current iterations of these health technologies as “early stages,” investors and founders construct shortcomings and failures as opportunities, pointing to the productivity of failure. In addition, these technologies are understood as the “first layer” of software and hardware on which the future will be built, and crucially, create a portal into a new type of consumer data through game-like interactions, which is how they work without working.

Early Stages, Long Promises: The Future Opportunities of Present Shortcomings

Several of my participants described health and wellness technologies, particularly wearables, as being in the “early stages” of their development as a way of explaining away the shortcomings that they themselves note, including their low user engagement, inaccuracies, and lack of actionability. Rather than seeing these issues as shortcomings, they consider these issues to be indicative of the “early stage” that these technologies inhabit—these failures are built into the trajectory of consumer electronics and are therefore expected. Framing these technologies as in the beginning of their development allows founders and investors to project two different kinds of superimpositions onto these technologies. First, investors and founders can imagine
these shortcomings as a phase in a longer trajectory of these technologies, such that projections about successful futures can be superimposed upon the shortcomings of the present. Second, they use the logic of “early stages” to superimpose the trajectories of economically successful consumer electronics companies, such as Apple, onto current health and wellness technologies as a way to justify their excitement at the opportunities that lie ahead. These participants see huge economic potential in these technologies and thus inevitable value in their futures, especially evidenced by the entrance of major consumer electronic companies, like Apple into the market.

In so doing, consumer electronics trajectories become the precedent in and through which these consumer health and wellness technologies and their futures make sense and create value. Investors and founders use “early stages” to construct the tracks—the groundwork—through which these consumer health and wellness technologies can become thought of as part of the same general phenomena—with the same futures—as consumer electronics. In so doing, my participants render the future economic successes and technical sophistication of these technologies real, anticipatable, and inevitable.

Patrick, a venture capitalist, uses this logic of “early stages” to excuse the inaccuracies of current fitness trackers and simultaneously argues that these technologies have the capacity and the promise to improve given the excitement they have already garnered:

I think we're still at the very early stages of it. As excited as people have gotten for some of these fitness trackers, they're still generally fairly inaccurate. I think step counting is the stage we're at now. My guess is over the next 5 or 10 years things will get a lot more sophisticated. That's what excites me about it, is I think we're just scratching the surface and there's a lot more to be done.

In defining the present moment as the “early stages” of these technologies and devices, Patrick qualifies the fact that these devices are fairly inaccurate, even though consumers and investors alike are “excited” about them. Excitement is manifest in investments, sales, and the proliferation
of these companies and devices: despite these initial shortcomings, these technologies have
developed a robust market. Thus, Patrick sees this excitement as warranted because these
technologies are only beginning to “scratch the surface” and delve into their future possibilities
and potential. Thus, for Patrick and others, the wearable paradox is not a paradox at all, as the
growing market justifies investor excitement and therefore high valuations, despite the product
limitations. Patrick forecasts that in 5-10 years, the computing power and complexity of these
technologies “will get a lot more sophisticated.” Describing these technologies as in the “early
stages” makes their progress and future success feel inevitable, thereby justifying their present
value.

In the epigraph, Peter Thiel and Fitbit would have us believe that startups are uniquely
positioned to anticipate and build the future. Indeed, part of Patrick’s craft as an investor is to
consider how these early stages are setting up the more sophisticated future of these devices and
apps. He emphasizes the logic of “early stages” in claiming that these technologies are “just
scratching the surface” of the kinds of value they can have for consumers, investors, and
companies. While Patrick does not articulate what exactly is below the surface, he is convinced
that the startups developing these products are capable of scratching successfully—i.e., building
the future—because some of these companies have already achieved economic success and
proven value in these early stages; they have already demonstrated their capacity to, as Thiel
claims, think differently. Within this logic, these technologies do not have to work (yet) to be
exciting (now). Constructing these technologies as in their just “scratching the surface” in the
present allows investors and founders to render conceivable and inevitable their exciting future.

However, there is a second type of superimposition that investors and founders make
when projecting the future of these technologies. Other investors and founders superimposed the
trajectories of economically successful and computationally sophisticated consumer electronics onto consumer health and wellness technologies to explain their inevitable economic success.

For example, Ethan, a founder of a health and wellness company, recalls the shortcomings of the first version of the iPhone as a way of explaining his faith that wearables like the Apple Watch or a Fitbit tracker will improve dramatically in the future:

I don't think the Apple Watch is perfect but this is the V1[version 1]. I don't know if you remember V1 of the iPhone, it was terrible, right? Well, relative to what it is today it was terrible and so I'm sure that by V3 Apple will have figured out some really interesting things that are more meaningful or they won't and the product will die but they placed a pretty big bet on this so I'm willing to bet they'll figure something out.

Typical of the technology sector, Ethan sees these initial shortcomings as part of the process of developing a technology. But additionally, by superimposing the economic success of other consumer electronic companies onto that of these consumer health technologies, he constructs their success as inevitable and these failures as critical to that success. In so doing, Ethan and others are setting expectations about how these technologies will work, the kind of market they will produce, and the role they will play in consumers’ lives. They are not only projecting future economic successes but also use these shortcomings as evidence that these consumer health and wellness technologies are already on the same trajectory as the iPhone, such that they are already on a path to fundamentally altering consumer life. In this light, the fact that wearables do not work proves to Ethan that these technologies are working because they are therefore following the precedent already set by successful consumer electronics. Ethan thus frames the potential value, utility, and technical sophistication through the exemplary successes of technology giants like Apple and their products as a way to map, pre-define, and render anticipatable the trajectories of other devices. Indeed, part of the work that these technologies do in “V1” is to
create and define the standards for how these technologies become more useful and meaningful to consumers.

Both Ethan and Patrick use these limitations to forecast the impact these technologies will have, which is framed as potential they already hold. Ethan and Patrick make allowances for this ‘version’ of these technologies to be terrible, because the first step in making them meaningful and interesting is to make them in the first place, however flawed those initial versions might be. In V1, which both presupposes and sets in motion the possibility of V2 and beyond, these technologies are not expected to be good—they are, in fact, expected to be terrible. However, for version 3 to be a vast improvement, consumers and investors need to commit to these technologies now. Patrick and Ethan are pointing to how consumers and investors have already committed to these technologies that do not work, as evidenced in sales and downloads, and this commitment allows them to anticipate what they see as inevitable, future potential.

Moreover, the entrance of a consumer electronics giant like Apple into this market is seen as proof that these devices will not only survive but will be improved upon iteratively. According to my participants, these technology giants would only enter this market if they could expect economic success. Additionally, because these giants have built up their economic success by making devices that they can convince consumers to want even if they are “terrible,” my participants are “willing to bet” that excitement in these technologies is warranted and expectations of future technical sophistication justified.

**Building the Data Infrastructure: Creating a Data Portal**

Investors and founders frame “version one” technologies as the early stages of building the technical infrastructure to render legible the mundane and quotidian activities of consumers’
lives. The critical work that these technologies do is create a portal through which previously inaccessible data about consumers’ intimate, personal, everyday lives can be continuously generated and aggregated. These health and wellness data include heart rate, skin temperature, sleep patterns, sweat composition, meal choices, social interactions, mental acuity, and activity level, among other things. According to the investors I spoke with, the data collection capabilities made possible by these technologies are crucial to how these technologies generate value in the present.

Many of my participants argue that these consumer health and wellness technologies critically provide access to a dataset that did not exist before; in fact, by virtue of providing access, these technologies create these data in the first place. While they recognize that these technologies are flawed, they view these devices as a necessary starting place. As Nate, a venture capitalist with experience investing in both healthcare information technology companies and consumer software companies, says, “[Fitbit and other wearables are] a good start. We have to start somewhere…you have to collect the data and they are really rudimentary… We are at Release 0.1.” That is, Nate justifies the “rudimentary,” “Release 0.1” state of the data—and therefore the limited functionalities of these devices—as a result of the nascent quality of the data collection. Similarly, Craig, a venture capitalist specializing in early stage investing for software companies, argues that these technologies are “super critical because [they] allow for the collection of data. Data collection is the key to where it all starts and that's what it does.” Patrick echoes these claims by calling these technologies a “gateway to the underlying data center.” For many investors, collecting these kinds of data at all is enough to make these technologies promising, regardless of data quality, because the “starting” place is establishing the portal to access this new set of data. Building this infrastructure to access and collect new data
about the quotidian activities of consumers is “the key” to allowing for “richer,” more complex datasets in the future. Nate thus treats these technologies as a first layer of software on which the future will be built, arguing that “We just have to put the building blocks in place before we can really build on top of it.”

For many founders and investors, the data portal foundation that is being laid now, the inevitably improved data collection and sophisticated analytics that will follow, and the capturing and correlating of ever more information, will enable future companies and devices to “do more things” with the data, as Nate puts it. In turn, these technologies will be able to provide more meaningful and useful insights to the user, thereby enhancing consumer engagement, that will then translate into increased sales and economic success. While Craig argues that these technologies are “consumer toy-like things” right now because “it doesn’t do much yet,” he and other participants are prepared for a long term horizon for these devices to develop. Craig says, “Over time, right? Time — data collection takes time. Start putting [these wearable technologies] on today, you're not going to know what kinds of analysis you can run in ten years, yet.” Craig sees untold value and promise in the ability to collect these data in the first place, which makes possible the construction of a database that will generate value over time. Such a robust and long-term database thus requires assembling now, setting aside and even normalizing the technologies’ current limitations to enable future data-driven possibilities.

Building the Technology Infrastructure: Consumer Toys

The fact that these devices feel like toys and create a fun experience for the user is critical because they cannot feel like a data portal for the consumer, even if that is critical to how founders and investors see value in them. My participants often used the term “consumer toy” to indicate the low clinical utility of these devices, arguing that these tools are like toys when
compared to medical devices that are integrated into clinical care. At the same time, they also understood the ‘toy-ness’ to be a crucial part of the appeal of these consumer devices and thus critical to how these technologies can collect data in the first place. I illustrate how, according to my participants, these devices have to feel like engaging products that also collect data in order to convince consumers to commit to these technologies and live with them. I argue that this is another way that these technologies work without working—they create a portal into a set of data without feeling like just a portal where data are being extracted in an overt, instrumentalist way.

For some of my participants, this toy-like nature of these technologies are part of their innovation, because they provide a compelling, game-like service for consumers that also allows these companies to seamlessly, almost invisibly collect data as users interact with them. The fact that they are consumer health and wellness technologies affects how they are designed to work in the first place—they are designed to be gamified, for people to experience them as interactive and playful, and in turn be integrated seamlessly with the rest of consumer life. Consumer electronics and consumer health and wellness technologies become indistinguishable. In this light, the shortcomings of these technologies pale in comparison to the value of the intimacy and closeness, and increased consumer expectations and desires for such closeness, that these technologies foster, allowing for unprecedented access to the consumer’s every-day life.

For example, Nikhil, a founder of a leading health technology startup, reflects on these points at length and emphasizes, enthusiastically, their importance:

What [Fitbit] did around the consumer experience—it's phenomenal. Yes, but people don't keep [using] it, it's maybe not actually changing behavior, there's lots of issues around quality and blah, blah, blah, blah... you have to build a compelling product to get data. You can't be a data collection device. You have to be a service that then allows you to collect data. Jawbone, Fitbit, all these guys. They created a service that people love and, as a result, they now have the opportunity to [collect data]. There is actually an order. You can't be a data company before you're a product company.
Like others, Nikhil acknowledges but simultaneously dismisses the well-known shortcomings of these devices because they distract from their main innovation. These toys are creating a fun consumer experience that feels like a service, that feel like something consumers actually enjoy, and this has allowed them to collect data. Mason, who has experience working in the public sector as a regulator and in the private sector as a founder, likewise sees much promise in consumer health and wellness technologies because of the intimacy these companies and their devices have fostered with their users:

I think the consumer side of health is going to be where most of the innovation’s going to happen…ultimately it’s [consumer health technologies] the thing that you take everywhere with you, and there's a lot of power there. The Fitbit that you wear on your arm, you wear it when you're awake and when you're sleeping. It's so close to you. We have these devices in the consumer world that are intimately yours…so close to you, that knows so much about you.

So while Craig’s excitement comes from the fact that these companies are building the data portal, what Mason and Nikhil see as additionally innovative is the fact that these companies have created an engaging and compelling service that allows them to collect these data in the first place. They are with the consumer at all times, everywhere, by choice. Consumers are choosing to commit to a relationship with these devices (and the companies that produce them), in part because of the compelling and fun services they provide. These devices and applications are also designed to feel really personal and are made to feel like they are for you. For Mason, “there’s a lot of power” in this kind of relationship that the company, via the device or app, can have with the consumer. The intimacy these devices foster has been inaccessible to traditional healthcare, and until now, unprecedented and even unimaginable for the consumer health sector.

The toy-like nature of emerging health and wellness technologies therefore becomes essential to the value and existence of the portal itself: It provides “exponential value” for the
consumer according to Patrick, and, at the same time it does the equivalent for the companies themselves. Participants like Nikhil, Mason, and Patrick sees the toy-like gamification as a critical component to the innovation of these technologies, because the consumer does not “necessarily think about how [they are] building this data set” and instead, simply “like playing this game,” according to Patrick. In this fashion, then, Patrick is able to refer to these health and wellness technologies as a “Trojan Horse into the actual data center,” where the compelling, game-like experience of these technologies distract the consumer from noticing the way that these devices also function as a data portal. And, as I explore further in the Chapter 4, the toy-like nature of these devices embodies key assumptions about what kinds of people are imagined by these devices as well as what it takes to produce consent and comfort with the lifestyles and relationships entailed in these technologies.

LAYING THE DIGITAL INFRASTRUCTURE: DATA INTEGRATION

While my participants construct promise in these technologies through the logic of early stages, which, in part, set in motion a data portal for these intimate technologies to take hold in the everyday lives of consumers, these future payoffs are being *built* in the present through data integration. Data integration represents *how* this future is made possible; my participants claim that while creating the data portal is a start, data collection in and of itself is not the end. A critical mechanism through which value gets constructed in health and wellness technologies is from the infrastructure getting assembled to make these data *meaningful* by integrating them together. Making data meaningful is what moves these technologies from the consumer toy phase to what Craig calls something “of grave importance,” affecting health, life, and death, and is critical to how these data are understood to become more complex, rich, and, eventually more valuable. Thus, these technologies also work without working by laying the groundwork for a
data-integrated future by standardizing the idea of data integration in the present. In this section I provide some background on what data integration means and how it works as well as explore how it assembles a digital infrastructure by creating standards for how data move, are made meaningful, and become economically valuable.

*How Data Integration works*

Part of the promises that Patrick, Ethan, Nate, and Craig discuss above involves more sophisticated computing and analytics that will move these technologies beyond the “early stage.” According to many of my participants, this increased analytic sophistication comes not only from increasing the amount of data these devices collect but also from integrating data from multiple platforms and devices together. Data integration is already well underway (note that Ethan’s company, which contracts with large health systems to integrate their patients and policyholders’ data across the consumer and medical apps and devices that patients use, would not exist otherwise). In fact, many consumer-facing health and wellness technologies are designed to work together and with other similar technologies, and this data integration is often a critical component of their business models. Data integration is often effected through what is known as “open APIs,” or open application programming interfaces, through which a company can access another’s data (sometimes a subset, depending on what data is made available) or provide other companies access to their own data. For consumers, open APIs are advertised as a mechanism for compiling data from various health and wellness applications into one convenient place. For developers, open APIs allow them to build applications on top of the services provided by the company with the open API. That is, when a consumer integrates their data from Application A into Application B, Company A can then access the consumer’s data from Company B, which Company A can then use to run analytics about that user and their behavior.
For example, Fitbit, produces a series of wearable fitness trackers with a companion application. Fitbit’s business model includes partnerships with independent applications; the user can then choose to integrate Fitbit-collected data with those other applications, to give themselves additional information within the convenience of the Fitbit web and mobile interface. Thus, a consumer can join information from Fitbit about their sleep patterns, skin temperature, and activity levels, with information about their calorie consumption from a calorie tracking app, such as MyFitnessPal, and data about their “brain training” and cognitive functioning from Lumosity. Fitbit advertises itself (see Figure 3.1) as the first fitness tracker with an open API in its marketing materials. Having an open API is clearly a point of pride for the company and represented as a selling point for developers and consumers. Companies claim that data integration joins diverse data in a meaningful way for consumers because the way the data are merged and presented purportedly demonstrates relationships across data, as Fitbit argues in Figure 3.2:
In addition to enabling more sophisticated computing and analytics, data integration is also understood to be a critical first step in assembling a universe of connected devices and environments known as the Internet of Things (IoT). IoT refers to internet-connected or “smart” objects that can continually collect data and communicate with each other, for instance through RFID chips and sensors, producing a “global network interconnecting smart objects by means of extended Internet technologies” (Miorandi et al. 2012:1497). Smart objects refer to objects that can “carry chunks of application logic that let them make sense of their local situation and interact with human users. They sense, log, and interpret what’s occurring within themselves and the world, act on their own, intercommunicate with each other, and exchange information with people” (Kortuem et al. 2010:44). The proliferation of sensors in smartphones and wearables, especially communication sensors described in Chapter 2, such as those that enable Wi-Fi and Bluetooth connections, are also critical to the possibility of IoT. According to Islam and Want
“smartphones have been one of the greatest drivers of pervasive computing” due to their sensing capabilities, context awareness⁷⁰, and continuous internet/network connectivity. IoT is already underway, as consumer objects, from refrigerators and thermostats to cars, jewelry, and clothing become equipped with sensors that enable this kind of cross communication and internet connectedness. The increasingly sophisticated data and analytics discussed earlier in the chapter are understood to come from progressively networked devices that are able to communicate with each other. In order for this cross communication to be possible, the data from these diverse sources must be integratable or interoperable.

Increasingly, IoT is imagined within a health and wellness context, and several of my participants described hypothetical scenarios where a consumer’s car, knowing that the consumer had not gone to the gym in several days, would drive automatically to the gym without the consumer’s intervention, or a home appliance would automatically produce a sugary drink for a consumer with diabetes because their glucose sensor, detecting a low blood sugar level, would seamlessly communicate that information to the appliance. Data integration thus becomes an integral process through which IoT is made possible and realized, and the mechanism through which the IoT future is imagined to affect consumers’ health. For founders and venture capitalists, therefore, data integration becomes critical for justifying the value and promise of these technologies, because it lays the groundwork for an IoT future that in turn relies on the proliferation of these connected, integrated devices.

Data Integration: Building the Infrastructure of the Future

In its marketing materials from its website (see Figure 3.1), Fitbit reminds visitors that it was the first internet-connected fitness tracking device manufacturer to open its API so that developers could build on top of their platform, and to allow consumers to integrate other apps
and devices with Fitbit. According to my participants, Fitbit’s open API is helping create this as an industry standard, and in so doing, assembling a critical infrastructure through which more meaningful, interpreted data is made possible.

Miles is the founder of an IoT technology company that is actively working on building the infrastructure of data integration. He sees data integration as critical to creating technologies that can communicate with each other, regardless of manufacturer.

It's exciting to be able to create a[n] infrastructure—the platform—that will allow people to completely change the world and the way we interact with it…. It's [Fitbit’s open API] a revolutionary business model [and] a major achievement for them. They’re not going to be able to build all the applications. They can't possibly know what next cool app is going to be big, but they want to enable these revolutionary apps to be built utilizing their devices as well…. You look at other standards like VHS…and you look at the internet and HTP you write, and all of these things, it's going to evolve. It's going to take some time, but eventually somebody will come out on top.

While the standards for this data-integrated future is still being worked out across several companies and industry consortia, Miles argues that data integration is a foundational platform that will enable revolutionary technologies to be created and, at the same time, creates data integration as a standard. Because open APIs allow developers to build technologies on top of an existing software, the open API is the crucial first step—the platform—in allowing others to build out additional technologies.

In the era of Big Data and increasingly datafied consumer life, data integration is viewed as crucial to realizing the value and promise of all these data, so much so that data integration is itself a standalone business model. Indeed, founder Ethan’s company’s entire business, which has raised substantial venture capital since its founding, is solely focused on integrating data across devices and platforms. The capacity to not only produce but also integrate data or allow your data be integratable is crucial to how value is produced in these technologies. For
companies that open their APIs, it is often a business choice to become relevant and get noticed.

As Corey, a physician and founder of a digital health and wellness company, explained:

They [founders of small startups] really want to make sure that their data gets out there and around. You're talking about these little companies that are trying to bang the drum and be heard in the giant chamber, in the dark fortress of medicine. They're trying to like turn their light on and say, 'Look at me here! I've got data! Come look at it!'

Corey is pointing to the crowded nature of the consumer health and wellness technology sector—there are hundreds of companies developing these products. To him, in order to garner attention, these companies must open their APIs and make their data integratable so that other companies and the healthcare sector can see the value of their database. At the same time, large companies like Fitbit and Jawbone are, as Miles explains, creating industry standards that produce them as a software platform because they recognize that they cannot build “all the applications.” But if others can use some of these companies’ data and build on top of their software, this increases their functionalities and simultaneously produces them as a foundational, infrastructural company of the future. Thus, startups create value in their data by drawing attention to it through an open API and more established companies with open APIs produce value in themselves as the groundwork of the future.

These founders and investors are also making data integration an economic standard in addition to a technical one. To Miles, it is a revolutionary business model—crucial to driving interest in a company’s products and keeping consumers engaged, and therefore a critical to market success. Open APIs and integrating data is becoming an economic imperative for these companies, as technologies that fail in the market are considered to fail in part because of proprietary data and closed platforms. To increase the value of these technologies for consumers such that they keep coming back, some of my participants argue that the data needs to be
“processed” via integration with other data in order to produce more meaningful information. According to Ethan, integrating step data, geolocation data, and transaction data from businesses allows for “really meaningful insights and that would be valuable. The data in and of itself, it's not that valuable. You have to interpret it.” Value is produced in the interpretation, made possible through data integration.

Part of why integrated data is considered more valuable is because my participants assume that these data are more “actionable,” meaning that the user can do something—can act—based on the story presented by integrated data. For example, founder Kyle presents a scenario in which an app uses integrated data to tell a user

‘I've [the app] noticed that on days when you go to sleep after 11:30, you tend to eat more poorly the next day, and in the long run, that leads to gaining weight.’ That's suddenly a much more actionable, personal insight than you can’t get if it just says, ‘You got to sleep at 11:30 last night.’ It's going from raw data to making it something that's actually meaningful.

Presenting this kind of packaged information to a user is considered more “actionable” than data that provides this information singly, because it cannot, on its own, point to actions that the consumer can take. According to my participants, once these feeds are packaged together, however, the application can provide the user with an integrated story of their tracked behavior that seems to correlate these data together (e.g., see Figure 3.2). For many of my participants, actionability is at the heart of the promise of data integration. They also make actionability possible only through data integration as relationships among data are made visible and accessible to the company and the user. These data-integrated packaged stories, called “insights,” are imagined to incite action—to inspire consumes to change their behaviors because the packaged story gave the user a clear path to change (as I describe in greater depth in Chapter 4).
However, Kyle also points out that integrating data, while underway, is a laborious engineering task that requires significant resources. He says, “There's the sense that oh, that data exists so we should be able to make it useful. Making it useful is really hard. Making it useful takes a lot of time.” So while building the data portal is important to provide access to these data in the first place, creating meaning, which requires considerable effort, is the next step. Indeed, Ethan’s data integration company markets itself as tool to access and maintain open APIs for a company because of the significant work and resources it requires. Kyle likens data integration as to oil refining: “It's like refineries in the oil industry. You can get the oil out of the ground, but you still can't put that in a gas tank. You have to ship it and put it through a refinery.” Like raw oil, raw data needs to be processed and made meaningful through integration. Kyle calls this process pipe-laying, where companies are figuring out how to “connect the pipes” and “get formats right,” thereby creating the standards for how data integration will work in the future.

These integrated data are considered more valuable because they broaden the utility of any given device or app and is understood to be more useful for users. If the data is made meaningful for consumers, they will continue to use the device or application, which means they will continue to provide the company with more data. Zach, a venture capitalist whose firm specializes in medical devices explains:

I think it [data integration] makes any individual product more useful and valuable. That's my point about how to keep consumers engaged with these technologies. The more useful information you get from it, the more engaged ... You'll stay. If you can share data and therefore broaden the value of any given technology, or device, or whatever, it makes it more interesting.

While having data that health and wellness technologies provide at all is a start, to get consumers to stay—to continue to use the application or device, thereby maintaining that data portal—the data have to be (made) meaningful. Given the crowdedness of the health and wellness
technology market, companies need to find mechanisms to keep consumers engaged with their
technologies, to continue to provide more data. Thus data integration creates more value in the
device or app for the consumer and creates more value in the data for the company. Zach argues
that having a proprietary platform, which makes it difficult for other companies to integrate their
technologies, has led to the failure of several companies, such as certain smart watch
manufacturers, because proprietary platforms cannot be broadly integrated with other devices
that are part of consumers’ lives, and therefore do not demonstrate “broad value” to consumers.
These failures further instantiate the necessity of data integration for product survival in a
crowded market. Startup success stories, such as Fitbit being the first to open its API, when
contrasted with market failures of companies with proprietary platforms and closed data, create
data integration as both an exemplary and increasingly routine business model and the standard
for market success.

Because Zach, Miles, and others construct “broad value” in open APIs and data sharing
practices, they construct data integration as an economic standard. The groundwork being laid by
these technologies is thus, in part, economic. The value of the data generated by these health and
wellness technologies is still getting worked out. As companies create open APIs as a business
strategy and investors construct value in data integration and the “insights” made available
therefrom, the work that these technologies perform ‘without working’ is to create the economic
standards through which the surviving technologies will and can create value. For my
participants, creating value in data comes from maintaining these data portals by getting users to
stay through integrated, meaningful, and actionable stories rather than raw data. By making data
integration crucial for financial success, investors and founders lay the economic infrastructure
for these technologies to improve and accrue value in the way they imagine; the business models of these technologies are themselves part of the groundwork.

CONCLUSIONS: WHOSE FUTURES?

In this chapter, I have tried to make sense of the wearable paradox and consider what work these health and wellness technologies do ‘without working.’ I have shown that as a result of the future-focused orientation of equity financing, much of the work these technologies do is to lay different types of groundwork for the future: the foundations for their inevitable success, the crucial infrastructure of a data portal, the production of (increasingly normalized) intimacy with toy-like devices, and the standardization of data integration and IoT as the business model for these devices. I have shown that to understand how value is constructed in these technologies, it is critical to consider the futures they make imaginable and possible and how these futures figure into and are built out of the current iterations of these “early stage” devices and applications. In addition, I have shown that investors and startups construct themselves as visionaries, as uniquely positioned to anticipate, invent, and build the future, inviting others to trust them and the future they imagine as the future we always already wanted. As visionaries, these actors necessarily build this future orientation—future promises, future revenue, future lifestyles—into the value and the design of their technologies in the present. In so doing, they are laying the groundwork for—and inventing—a future that only they can see.

But who is this future for? In whose interests is this future getting assembled? While many of these participants frame these technologies and their investments in them as altruistic and “good for everyone,” their interests, especially for publicly traded companies like Fitbit, Google, and Apple are to their shareholders and revenue projections. These companies are rendering these data possible and valuable based on their own interests and in ways that serve
them best financially, by growing their market. Because these technologies are understood to lay the groundwork for the future, the decisions they make about the design of these technologies, their business models, the kinds of data they collect, who owns these data, and how they are interpreted are becoming industry standards; these decisions are becoming the infrastructure and the architecture of consumers’ lives. As I describe in the introduction, the iPhone has a health application that comes standard with the phone’s operating system and cannot be deleted or disabled. The application is built into the device, and draws data from a built-in accelerometer, a default feature of the smartphone that tracks movement on three axes at all times. Most smartphones that run on Google’s Android operating system also have built-in accelerometers that measure “motion, orientation, and various environmental conditions.” To use these smartphones, the consumer has to agree to allow the device to generate and track the consumer’s activities and location at all times. While the market for wearable devices and health applications are far from saturated in the U.S. adult population, the Pew Research Center reports that “86% of those ages 18-29...[and] 83% of those ages 30-49,” own smartphones, which they argue nears market saturation (Anderson 2015). The pervasiveness, ubiquity, and default nature of sensors that enable activity tracking are already standards for most American consumers, regardless of whether or not they own a Fitbit or use health and wellness apps. There is no opting out of these “features;” when these decisions become the default feature of the devices that most Americans have and use constantly, we have always already opted in, without ever having opted in the first place.

While these features may be fairly recent, the data and design decisions were decided upon and set in motion years ago, when these companies “invented” the present. These actors are creating the infrastructure of the future because they are rendering their design and data
generation decisions as standards in the present. Without questioning these actors’ claims on the future, we are missing a critical opportunity to question the future they are already assembling and accruing value from in the present. The groundwork these actors lay and the work their technologies do is to codify their version of consumer life and how it is and can be measured, known, and capitalized on before we get there, so that their decisions are standards by the time we arrive. This productive forecasting means that the infrastructure of the future is always already assembled, and accruing value, without us. In the next chapter, I consider the kinds of people these futures require and how, like the digital and economic infrastructures described in this chapter, these people are assembled in the present in service of and to make possible those futures.
CHAPTER 4: ASSEMBLING THE SOCIAL INFRASTRUCTURE- INULCATING

SUBJECTS FOR THE FUTURE

_The problem of ideology, therefore, concerns the ways in which ideas of different kinds grip the minds of masses, and thereby become a “material force”_—Stuart Hall, “The Problem with Ideology—Marxism Without Guarantees”

INTRODUCTION

While consumer health and wellness technologies are proliferating in the startup as well as the large consumer electronic sectors, investors and founders cannot take for granted that these technologies, many of which effect unprecedented surveillance, will automatically become enmeshed into consumer life. For their part, consumers have to be enrolled into the kinds of lifestyles and mindset in which these technologies make sense and feel necessary. Drawing on theories of ideology and subjectivity, I explore how founders and investors construct these technologies to, as Stuart Hall (1986:29) has said, “grip the minds” of consumers such that they willingly submit to the governance and surveillance entailed by these devices. I argue that these intimate technologies require and produce particular kinds of subjects and subjectivities. Rather than assembling markets of people who choose to consume these technologies, I find that founders and investors of these technologies require, imagine, and produce subjects who consent to and live through an ideology of life-optimization, and who approach life in ways that align with their company’s products. Their construction of these requisite subjects becomes operationalized, made real, and continually re-inscribed, in the design and implementation of these devices. By introducing consumers to a version of life and health that is lived through, measured, and known through interaction with these technologies, the companies developing these devices also make consumers comfortable with and even reliant on the progressively technically managed and technically mediated lives that these companies render. I argue that, as
these technologies develop and proliferate, inculcating the right subject becomes increasingly important (because data needs to be collected continuously) and increasingly possible, because data collection is progressively collected in the background—sometimes without consumer knowledge.

Following provocations from the previous chapter, I consider the work that these technologies perform without working. In this chapter, I show how consumer health technologies are making possible and available in the present these future subjects by rendering particular kinds of lifestyles understandable, accessible, desirable, and self-evident now. This intricate inculcation is thus a crucial part of the work of groundwork laying; installing subjects into the infrastructure of the future requires careful enrollment that makes living with and through these technologies comes to seem both normal and necessary. Larkin (2013:333) has argued that infrastructure can “form us as subjects not just on a technopolitical level but also through [a] mobilization of affect and the senses of desire, pride, and frustration, feelings which can be deeply political.” Drawing on these arguments, I contend that the production of subjects becomes part of the infrastructural work that these technologies perform. I call this the social infrastructure of these technologies, wherein this careful inculcation strategically makes subjects available for the future market by normalizing particular forms of living and subjectivity in the present. Others, such as Noble and Lupton (1998), have described similar processes in their exploration of how subjectivities co-articulated with the integration of computers in the workplace. I contend that for “early stage” consumer health and wellness technologies, assembling this social infrastructure is equally as critical to work that they perform as the digital and economic infrastructure-building described in the previous chapter.
I begin this chapter by drawing on Gramsci, Althusser, and Foucault to theorize the subject and explore how these technologies proliferate by creating willing and consenting consumers. I then consider key principles of popularized versions of behavioral economics deployed in the design of consumer health and wellness technologies as well as the subjects imagined by these principles. Drawing on my fieldwork, I then explore the subjects hailed by consumer health and wellness technologies and describe how these subjects are assumed and accounted for in the design of these devices. Next, I consider how consumer health and wellness technologies are already assembling a social infrastructure through which an increasingly tracked future can be realized. I argue that these technologies work without working in part because of this subjectifying infrastructural work. Finally, I consider how the construction and assembly of these subjects also follow imperatives to broaden the market for these devices, and therefore need to make economic sense. I conclude by contending that these technologies install a form of technically mediated, managed, and effected governability into the infrastructures of consumer health and wellness technologies.

THEORIZING THE SUBJECT

Consumer health and wellness technologies require particular subjects who think about, approach, and act on and towards themselves in particular ways. The goal of this chapter, then, is to explore what kinds of subjects are needed and how they are being constructed. Following Stuart Hall’s question in the epigraph, I am interested in how particular ideas about health and life come to propagate. To understand the ideological work of these technologies, I am thus interested in the subjectifying work that they do—how they produce and require people who take up those ideas in ways that continuously re-inscribe them. I turn to Gramsci’s theory of hegemony and common sense, Althusser’s theory of interpellation, and Foucault’s theories of
subjectification and objectification. Gramsci, Althusser, and Foucault were centrally concerned with how governable subjects are produced, and each foregrounds different processes through which I can explore the subjectifying work of these technologies.

Neo-Marxist Antonio Gramsci famously theorized hegemony to clarify how ideas of the ruling classes are disseminated to, taken up by, and “organize human masses, and create the terrain on which men move, acquire consciousness of their position, struggle, etc.” (Gramsci 1999:707). For Gramsci, hegemonic power stands in contrast to coercive power, the latter of which is a form of violent power deployed by the State to discipline its subjects, while the former operates through consent. Through hegemonic power, the ideas of the ruling classes are disseminated into the consciousness of the masses such that these ideas organize their lives and their thought, thereby achieving consent to exploitative relations of production. Thus, for Gramsci, governable subjects are made through a combination of coercion (violent power) and the strategic production of consent (hegemonic power) that produces compliance. Consent is effected through what Gramsci calls common sense, meaning the “‘spontaneous’ feelings of the masses,” and “the traditional popular conception of the world” that “are not the result of any systematic education activity…but have been formed through everyday experience” (Gramsci 1999:433). In this model, consent is achieved by making the ideas of the ruling ideas feel self-evident and natural.

In his chapter on “Ideology and the Ideological State Apparatus,” neo-Marxist Louis Althusser (1971) examines how relations of production persist in a constantly regenerative form without intervention or overt, heavy-handed practice. He focuses on the role of ideology, arguing that in order for capitalist relations to endure, the state produces subjects who are "'steeped' in this [ruling] ideology” such that they “perform their tasks 'conscientiously'" and thus “submi[t] to
ruling ideology” (Althusser 1971:132-133). Althusser argues that this process of inculcating/steeping works through what he calls interpellation, where ruling ideology hails (interpellates) individuals such that they come to recognize themselves as subjects, despite always already being subjects, even prior to birth. Through interpellation, individuals are led to believe that they are choosing to become subjects in that moment, in their material practice of 'freely choosing.'

By pointing to the practiced aspects of ideology and subjectification, Althusser shows how capitalism creates subjects who subject themselves—who make themselves governable—through a subtle process of (mis)recognition, in which individuals feel that they are choosing particular forms of living and acting, when, in actuality, they are merely re-inscribing their own subjection. To Althusser, capitalism requires (and therefore constitutes) these kinds of subjects—those who work all by themselves, allowing ruling ideology, its subjects, and economic relations to be continually reproduced.

For Foucault, the subject has two meanings: one who is “subject to someone else by control and dependence; and tied to his own identity by a conscience or self-knowledge. Both meanings suggest a form of power which subjugates and makes subject to” (Foucault 1982:781). Foucault (1993:203)argues that relations of power affect and discipline individuals and their conduct, “impos[ing] certain wills on them and…submit[ting] them to certain ends or objectives” from the outside through technologies of domination.

Like Gramsci and Althusser, Foucault was interested in theorizing technologies of power elaborated more through subtle coercion than overt violence. This subtle coercion takes two forms: technologies of domination and technologies of the self. Technologies of domination
render the subject an object (objectification) of disciplinary power and normalizing judgment through various tactics of training, observation and surveillance, and calculation, and additionally through invigilating knowledge practices of writing, classification, and information. Thus, through these various disciplining techniques and knowledge production, the subject is continually rendered as governable object.

Foucault (1993:203) also argues that subjects effect their own subjugation by producing themselves as subjects through what he calls technologies of the self, or “techniques which permit individuals to effect by their own means or with the help of others a certain number of operations on their own bodies and souls, thoughts, conduct, and way of being, so as to transform themselves.” This kind of technology is subtler and finer than technologies of domination and is “foremost about guidance,” that shapes subjects’ choices. Rather than being shaped by power over the body, technologies of the self shape the subject from the “inside out,” affecting how they approach and act on themselves, their identities, and their lives (Clarke et al. 2010). As with technologies of domination, the production of knowledge—in the form of regimes of truth—is critical to how technologies of the self effect subjectification. Here, the subject seeks to know themselves and their truths, often through outsourced expert mediation, producing a subject who is incapable of being “the final arbiter of his own discourse” (Dreyfus and Rabinow 1983:179). To Foucault, technologies of domination, technologies of the self, and their interaction are critical forms of governance over the subject.

In this chapter, I engage ideas from Gramsci, Althusser, and Foucault to understand how subjects are made to consent to their own subjection. Drawing on Gramsci, I ask how consumer health and wellness technologies produce particular kinds of people by producing consent and comfort with the lifestyles that they entail. In particular, I use Gramsci’s concept of common
sense to argue that certain notions of the “subject” are secured by being made to feel self-evident. In Chapter 3 I explored how these technologies work by creating standards and default procedures that set in motion a particular future. In this chapter, I ask how consent is itself installed in and through infrastructure—through the strategic creep of default features and quiet standards that come to feel natural. I also draw on Althusser’s theory of interpellation to consider how subjects are inculcated into the logics of consumer health and wellness technologies by (mis)recognizing themselves and their truths through an illusion of options and opting for optimized life. I specifically consider how the feeling of choice produces consent to the surveillance and governance effected by these technologies. Lastly, I draw on Foucault’s theories of subjectification to ask how consumers are subtly governed to work on their lives, identities, and bodies through these dominating and subjectifying technologies and, in this work, simultaneously produce themselves as governable objects. In this chapter, I consider the following questions: What kinds of subjects are required for consumer health and wellness technologies to work? How do these technologies produce comfort and consent with the lifestyles entailed therein? How do they make themselves and the kinds of life they require feel self-evident? Before I examine these questions, I first explore the central tenets of behavioral economics, as my participants indicated that these principles informed the design and development of their technologies.

BACKGROUND: BEHAVIORAL ECONOMICS

Similar to Schüll’s (2016) findings, throughout my fieldwork, the notion and necessity of “behavior change” as a technical and economic imperative permeated conversations with founders and investors. In a world of consumer toys, the ultimate goal and metric of efficacy and utility is demonstrating some form of behavior change in the consumer, such as eating more
healthily, losing weight, or engaging in more physical activity. This is in part because these technologies occupy a liminal space between consumer toy and health technology; while they are designed to be “fun” and “cool” as well as insert comfortably into consumer life, the companies that are developing these tools rely on the continuous collection of data and regular user engagement, and therefore need consumers to keep coming back to the app or device. Founders and investors operationalized behavior change as a critical strategy to work towards increasing user engagement and maintaining the open data portal established between the consumer and the company. This is because they believe that consumers find utility in behavior change and will cease to engage with these products (and therefore cease to provide data to the company) if these technologies do not effect this kind of change. However, as I show in Chapter 3, these technologies do not have to demonstrate behavior change to be funded or considered valuable. Achieving behavior change is still considered a distant goal, the “holy grail,” as one participant says, that will cement these technologies in the lives of consumers over the long term.

But how did this happen? Where does this notion of behavior change come from? Many of the founders and investors I interviewed referenced popularized behavioral economic principles when discussing behavior change. In this section, I consider how ideas about behavior change and behavioral economics involve assumptions about the subjects that are both imagined in and produced by these technologies. Moreover, because founders and investors are interested in establishing and growing the markets for their technologies, I ask how these assumptions help assemble subjects that rationalize investment in these devices—how these subjects can make economic sense. In this background section, I describe the particularities of the subject imagined by popularized versions of behavioral economics and then track how that subject travels through the design of these devices and technologies.
Central Claims/Tenets: Irrationality

At its core, behavioral economics attempts to challenge the idea of human rationality and the *homo economicus* of neoclassical economic theory—the idea that humans are “calculating, unemotional maximizers” (Mullainathan and Thaler 2000:3) of “preference satisfaction” (Posner 1998:1553) who “are perfectly sensible, calculating machines” (Ariely 2010:6). Neoclassical economic theory understands buyers and sellers to be driven by the pursuit of self-interest and equipped with perfect information about their options. By contrast, behavioral economists argue that such assumptions are unrealistic and do not reflect how people actually make both economic and non-economic decisions. Based on empirical research, beginning with Kahneman and Tversky in the 1970s, behavioral economists believe that their studies of human behavior demonstrate that human decision-making is rarely rational. Instead, they assert that actors, because they do not always have all the information when entering the market, do not always make optimal decisions. Instead they employ a number of cognitive shortcuts (heuristics); are easily influenced and manipulated by contexts, message framing, and other actors; and do not always know what their preferences are and allow their preferences to shift. Behavioral economists construct this irrationality as a ‘natural,’ inherent, human flaw and part of the “basic wiring of our brains” (Ariely 2010:239). However, while they acknowledge that “human beings are irrational,” they argue that they are predictably and systematically so (Ariely 2010:6, emphasis added). In contrast to neoclassical economics which assumes that people make unpredictable errors in their forecasts, behavioral economists posit that peoples’ errors are patterned and based on systematic biases, rendering these errors predictable. Thus they believe that empirical research can, and must, define these biases and the resulting, systematic errors in order to build better economic models of human behavior.
Interventions: Nudging through Choice Architecture

Because humans consistently and predictably incline to irrational decision-making, behavioral economists believe that small interventions—called nudges—have the potential to steer us into making better decisions. Nudges can involve engineering the environment or the context in which these decisions are made, such as changing the size of food containers or the design of cigarette packages. In their national bestseller, *Nudge*, Thaler and Sunstein (Thaler and Sunstein 2009) call these interventions “nudges,” defined as “any factor that significantly alters the behavior of humans” using what they call “choice architecture,” where peoples’ behavior is influenced by deliberately “organizing the context in which people make decisions.” Behavioral economics thus dictates that consumers should abdicate their ability to make optimal choices to an infrastructure or choice architecture, which can be designed to encourage optimal behavior without their direct intervention or even awareness. Drawing on these principles, consumer health and wellness technologies aim to engineer choice by structuring the context in which those choices are made. In so doing, founders of these companies account for human irrationality in the design of their devices.

ENTAILED SUBJECTS: ACTIVELY NUDGED, PASSIVELY OPTIMIZED

In this chapter I argue that consumer health and wellness technologies create subjects who consent to the lifestyles these technologies require. These are subjects for whom continuous tracking feels desirable, justified, and self-evident. In this section, I argue that these technologies entail particular subjects—they are simultaneously implied, required, and produced by these devices. I use the term entail to suggest that assembling these subjects is as necessary to these the development of these technologies as their technical and financial components described in Chapter 2 and as critical as the digital and economic infrastructures described in Chapter 3. As
Gramsci, Althusser, and Foucault all argue, capitalism requires specific subjects to work—those who consent to their own governance and subjection through a variety of tactics. In this era of informational capitalism (see Chapter 1), wherein consumers are in part productive through the data they produce at every moment of life, I use consumer health and wellness technologies as a window into the subjects and consent required for these data to flow continuously. I contend that the subjects who are already entailed in consumer health and wellness technologies are: 1) life-optimizing subjects who rely on these technologies to render their lives and their bodies’ truths legible, 2) who recognize their own need for nudging, and 3) who seek to optimize their own optimization by outsourcing their health management to technologies that modify their lives and decisions for them.

_Rendering the Body’s Truths: Objectivity and Legibility_

![Mio Technology Corporation Wearables Advertisement](image)

Figure 4.1: Mio Technology Corporation Wearables Advertisement

Many of these consumer health and wellness technologies are designed, imagined, and marketed as windows into the body’s truths, some of which my participants argue were heretofore unavailable to consumers. Moreover, this window is uniquely marketed as a *continuous* view of the body, through constant data collection, suggesting that this exhaustive, *living* dataset is far more comprehensive and precise (and therefore more accurate) than what the consumer could measure or perceive on their own. In these ways, these technologies are constructed as infinitely “smarter” and more reliable that the consumer’s subjective experience.
of their body. As Figure 4.1 from wearables manufacturer Mio Technology illustrates, the subjects entailed in these devices “demand” this kind of objective, continuous measurement in order to understand their bodies. In her study of wearables, Schüll (2016:10) similarly argues that these companies construct the body as “not a sensing organ through which one gains self-knowledge but, instead, a data-generating device that must be coupled to sensor technology and analytic algorithms in order to be known.”

These perspectives were widespread among my participants. For example, Elliott, a marketer at a leading wearable company, argues that these technologies allow consumers “to know things they couldn't know before, that they couldn't see before. [These are] tools that make the invisible visible, to see things that were un-seeable.” Founders and investors construct these tools as providing a new form of visibility and legibility to the body that founder Anjali argues will allow consumers to “become more aware of [themselves]” and therefore “make better decisions” about their health. Additionally, Nate, a venture capitalist, argues that the uniqueness of consumer information actually provides more depth for “how to live better,” rather than just information about “disease states.” These technologies entail life-optimizing subjects who not only rely on these devices to measure and interpret their lives back to them, in order to stave off health risks, but also are constantly seeking (the best ways) to engineer a better life.

Nora, who directs communications at a leading wearable company, shows how claims of data accuracy and objectivity are “sticky,” meaning that consumers will continue to use the product because of this feature, and it is therefore a strategy for maintaining her company’s market:

I also think sleep information in particular is very sticky because you couldn't get that information without going to a sleep clinic [before consumer wearables]. You had no
objective measure of it before. Now we can get an objective measurement obviously in your activity levels.

To Nora and others these technologies provide new access to the body and its truths—“objective measurements”—about sleep and other activities that were previously unavailable to consumers outside the clinic. As communicated in Figure 4.1, these companies claim that consumers are already looking for this kind of objectivity, such that it can be “sticky” in the first place. The subjects that Nora and Elliott’s companies construct and require are those who (come to) rely on these devices for objective measurements about their lives.

Additionally embedded in these claims is the assumption that the truth provided is far more reliable and objective than the subjective human experience of the body. For example, founder Nikhil says that when patients are asked to recall their health between doctor visits, “Who's going to remember? How do you remember that? You're going to be biased. You just don't do a good job of that. We [his company] could provide that context to that clinician so they know.” The subjects Nikhil constructs and produces—including providers—are those who recognize and seek the superiority of these kinds of technologies to measure and represent their health and well-being over the human subjective experience.

The subject that these founders and investors imagine needs to be quantified and turned into data to be intelligible and legible to themselves and others, including providers. Moreover, by claiming to reflect the truth of the body back to the consumer, these technologies interpellate subjects by compelling consumers to recognize themselves in their datafied representations. These companies construct these data as information consumers always already needed, but did not have access to before, so that consumers recognize themselves as the life-optimizing market these companies need them to be.
Understanding how these truths are packaged and how these technologies are designed to work also reveals much about the tacit assumptions that founders and investors have of the subject. These technologies do not just provide consumers with datafied versions of their bodies. Rather, founders often design consumer health and wellness to technologies to nudge consumers to make different choices. My participants gesture to principles of behavioral economics by constructing these subjects as inherently unable to manage their own health not only for a lack of objective information, as described above, but also because their biology gets in the way. By constructing human behavior as inherently problematic, these companies entail subjects who recognize their own inferiority in optimizing the management of their own health and lives. Because these subjects value life optimization, they make their own bodies and lives critical sites for continuous data collection and intervention.

The interventions my participants design often take the form of nudging notifications that attempt to alter consumer’s decision-making through regular, informational feedback. Founder Lyra calls these interventions “hacking your instincts,” where a consumer’s biological instincts to, for instance, eat cake to “get you through the next famine” are countered using technologies to get consumers to eat more healthily. The term “hacking” is a Silicon Valley buzzword that often implies finding innovative, sometimes backdoor solutions to computing problems. Lyra uses the term to imply that, to optimize life, consumers need to subvert their own instincts and work around their biology.

For technologies that actively nudge, this “hacking” often takes the form of information or feedback to the consumer, such as reminders and notifications, which venture capitalist Randall says can “motivate[e] people to be passively aware of their health,” and act as a “little
push…to change habits.” For example, Lyra’s products are designed to provide informational feedback in addition to rewards to encourage consumers to use her products continuously. To her however, mere notifications do not provide sufficient “gratification” and “reward” to achieve behavior change. Her company advertises itself as providing “more than reminders,” by which she means that the product is designed to nudge consumers in a way that cannot be ignored, as she feels that consumers can get desensitized to notifications. Instead, she is designing her technology to provide strategic and immediate “rewards” for small, manageable goals:

You start ignoring reminders after a while. It's neuroscience again. It's desensitization. If I poke you the first time, you're going to respond. If I keep on poking you, you stop feeling it. That's why plain reminders, it's not enough. We nudge in a way where you can't get desensitized to it. That's what we mean by "more than reminders." The way we designed our products is that you get instant gratification for doing these short-term goals, like sit up straight right now. You can fix that right now. It's not like, "I need to get 10,000 steps by the end of the day." When's that actually going to happen? That's such a big goal. It's more like, "Can you [sit] straight for the next 15 minutes?" Then it's like, "Good job." Or, "You only need 200 steps right now if you want to stay on track for your goal." It's designed neurologically to reward you for doing something right now and being mindful, and that helps form the habit around the product.

Entailed in the design of Lyra’s technologies are subjects whose biology gets in the way of their health goals. She believes that her product’s reward system will allow consumers to “optimize their lives” by “hacking their instincts” through feedback. Their strategy is designed to turn health and life optimization via their technologies into a habit, thereby building and maintaining a market for their products through these behavioral strategies. Lyra’s technologies assume that consumers need constant feedback on their bodies and lives to make better decisions and, therefore, live a better life.

Opting for Optimal Optimization: The Passively Optimized Life

At the same time, founders and investors are imagining and producing subjects who elect for their lives to be passively optimized on their behalf. Drawing from behavioral economics-
informed “decision biases” and “choice architecture” discussed earlier, these technologies are designed to nudge consumers to a better life by optimizing their environments in the background rather than through datafied feedback. Much of this passive optimization is realized through an increasingly connected universe of technologies, known as the Internet of Things (IoT) described in the previous chapter. For example, founder Mason considers this passive optimization to be critical to the promise of these devices:

I'd say the internet of things is already here on these kinds of devices [health technologies]. I think the magic will come as this data flows. The software on top starts to piece these different things together, that's where the magic will be. If you're talking about a city, transportation logistics, being able to seamlessly flow traffic through a city, that same thing applies to your life. Using data to make you seamlessly live it a little better, by going for a run more often or drinking an extra glass of water when you don't know it.

With the proliferation of increasingly internet-connected devices, Mason sees integrated data from this universe of connectivity as seamlessly enabling passive optimization, so that consumers can live better without really being aware of it. These subjects need technologies to gently and invisibly nudge them to better health choices and better life by designing and manipulating the context in which their decisions are made. Miles, who has founded an IoT software company, similarly argues that the promise of IoT and data integration is that consumers’ environments, such as one’s home, will be seamlessly integrated with their health technologies, such that if a consumer’s blood sugar is low, their home appliances will automatically produce a sugary cup of tea. These subjects need only entrust this passive optimization to the data and the designers (choice architects) to live better. These subjects work on themselves without working. Or, rather, the work that these subjects do is in opting for technologies that optimize their lives for them.
While Mason imagines IoT to modify consumer choices, others articulate a vision in which these technologies use infrastructure to modify the environment rather than the consumer themselves. These life-optimizing technologies can run entirely and continuously in the background to work on the self on behalf of the consumer so that they no longer have to work on themselves, themselves. Such principles are already a critical part of the design of some IoT technologies. For example, founder Rakesh describes what he views as the ingenuity of Google’s NEST® product, a “smart,” internet-connected thermostat/home automation technology. Like others, he sees the promise of IoT is to use integrated data to modify consumers’ lives on their behalf:

IoT needs to evolve from just measuring to nudging. For instance, NEST®, being connected to the grid, you and your calendar, and things like that, it knows about you as well. It’s [therefore] able to do smart things like switch your heating off and turn it back on and control the thermostat to save you money and to be better for the environment. You don’t really have to interact with it very much. It does it silently in the background. [-Rakesh, Founder of Health and Wellness Technology Company]

These technologies are designed to learn from integrating diverse data, from the electrical grid to your personal calendar, in order to optimize consumer life—by correcting for their predictable irrationalities—“silently in the background.” This is in part because illogical subjects who neglect to adjust their thermostats upon leaving or returning, and therefore deny themselves cost savings, have been accounted for in the design of these devices. The only work the consumer has to do in this scenario, is opt for these technologies. Kyle, Rakesh’s cofounder, similarly describes a passively optimizing IoT future and present in these scenarios:

This is kind of a Jetsons future, but you start home from work, you get in the car and you get a message [from your car] that says, "Hey, you skipped your morning workout, but you've got time this evening. You want to do that when you get home?" Your car plays your workout music, gets you amped up. When you get home, the coffeemaker is not on, because it's not time to drink coffee yet. Your environment is guiding you toward the wellness outcomes that you care about. I think it's going to take a long time before that
happens but we're seeing bits and pieces of it now. Jawbone and several other wearables work with NEST® so when you go to bed, your speaker gradually fades into white noise, and then the white noise dims when you reach a certain point in your sleep cycle, and the thermostat adjusts to keep your house conditioned in the right way.

Kyle imagines a future in which the technologies we already engage with will be “smart” enough—by integrating a variety of data that is already being collected—to nudge consumers towards certain behaviors, such as not drinking coffee at night or going to the gym more frequently. The first, Jetsons-future scenario Kyle imagines triggered by missing a morning workout is presented as far off into the future (though some car manufacturers are already designing platforms to integrate with health technologies like glucose monitors, see Note 86). However, Kyle offers the Jawbone and NEST® scene as one that is already possible through IoT and data integration. In this latter example, activity trackers networked with sound systems and home automation systems are tasked with optimizing the consumer’s life on their behalf but without their direct intervention. It is assumed that these technologies, through integrated data, know best (because they are far more rational) and can therefore be entrusted to passively design the optimal sleep environment for the consumer without them. Crucially, this latter scenario—and the subjects entailed therein—serves as the building blocks for the Jetsons future, as subjects are becoming acclimated and inculcated into a passively optimized life.

In both Kyle’s and Rakesh’s scenarios, consumers need only provide these technologies access to their homes, schedules, and lives, to enable these devices to take over, to do “smart things” on their behalf, because (less smart and irrational) consumers’ systematic biases might prevent them from taking these actions on their own. Moreover, in accessing and analyzing data continuously from the electrical grid, these “smart” (and objective) devices are considered to have infinitely more information and a greater analytic capacity than consumers. The subjects imagined in and produced by these interventions are those who make predictable errors that can
be technically anticipated and intervened on. However, in addition, these are also subjects who seek optimal optimization. Because consumers can never be as “smart” as these devices, these subjects recognize the value of and therefore consent to a passively optimized life.

In many of these examples, the only work the subject needs to do to work on themselves is opt for optimal optimization. Several founders were working on mechanisms to make continuous data collection as seamless as possible so that once consumers have opted in, their work is (seemingly) done. Lyra and her team are designing one of their products, a waterproof necklace intended to be worn constantly, with this in mind. Lyra argues that optimizing one’s life needs to be “as easy as possible” for the consumer. This requires what she calls “low activation energy,” which she describes as requiring minimal effort so that “everything [is] as automatic as possible.” Indeed, as tracking becomes increasingly standardized in consumer technologies (as described in Chapter 3), opting in may already be as simple as using the smartphone you already have.

*The Feeling of Freedom: Opting without Options*

As I have described throughout, these technologies are designed to feel like they are for you, especially in as much as they offer behavior change interventions. Misfit Wearables, a leading wearable vendor in the U.S., advertises its smartphone apps as tools that are designed to make all aspects of consumer life easier:
As these advertisements indicate, these technologies are marketed as technologies that are not only for you, but are also for all aspects and all moments of your life—from the workplace, where you may need to navigate a slideshow presentation, to the home, where you can adjust lighting, to consumer life, where you may take a selfie. Indeed, as the smartphone image in Figure 4.2 indicates, activity tracking is just one of many features of a Misfit-run life and may in fact be a lower priority than taking a selfie. These devices offer a version of health and wellness that is as easy as, and perhaps as entertaining as, taking a selfie, making enrolling into an increasingly tracked life feel like less work and more like fun. These tools are personal—attending to each consumer’s personal needs, lifestyles, and aesthetics—entertaining, and easy.
Misfit tools are designed to seamlessly integrate with everything you already do as a consumer and are made to feel like their main priority is making all aspects of life easier, for you. Activity trackers are not just for health and wellness; they are for life.

In his theory of interpellation, Althusser (1971) argues that capitalism creates subjects who subject themselves through a subtle process of (mis)recognition, wherein individuals feel that they are choosing particular forms of living and acting, when, in actuality, they are merely re-inscribing their own subjection. He argues that this process creates the feeling of freedom and agency, which allows unequal relations of production to persist. Drawing on Althusser, I argue that in constructing health and wellness technologies as offering consumers the truths of their bodies, founders and investors design these technologies to hail subjects through datafied representations of their lives. The techniques of actively hacking one’s instincts and opting for optimal optimization are also designed to feel like agency. In all of the examples of entailed subjects, the consumer is always already seen to be inherently inferior in their ability to manage, know, and interpret their own bodies and make the best decisions for themselves. Because these consumers recognize themselves as people who value optimization and recognize the superiority of these devices to tell them their truths, they feel as though they are opting into optimal optimization, which makes it feel like a choice rather than a surrender. Moreover, as the advertisements in Figure 4.2 indicate, these technologies are carefully designed to make these tools feel like they are for the consumer and all aspects of consumer life, which makes opting in feel like a choice one makes for oneself. However, drawing on Althusser, I argue that this is a misrecognition. Consumers, by feeling as though they are opting into these technologies, misrecognize these technologies and a tracked life as optional and voluntary in the first place. Additionally, they misrecognize the superiority of these devices to render their lives and bodies
legible (and optimizable). As I have shown in Chapter 3, as tracking becomes increasingly standardized and ubiquitous, subjects do not actually have the choice to opt in, because the “choice” has always already been made for us. Consent to an ideology of life optimization and continuous, datafied surveillance is therefore produced and maintained through self-subjection that feels like an option.

INULCATING SUBJECTS AS INFRASTRUCTURAL WORK

As evidenced by the proliferation and popularity of consumer health and wellness technologies among U.S. consumers, the subjects and consent I have described have already taken hold. This is in part because once a consumer opts in, by purchasing a smartphone, a wearable, and/or downloading a health and wellness app, they enroll themselves into the logics of these devices. In this section I argue that by enrolling subjects, consumer health and wellness technologies, particularly pioneering wearable companies like Jawbone and Fitbit, perform significant work. Following themes from Chapter 3, I contend that these technologies work without working by making the kind of life that these devices require available, comfortable, and self-evident. Following Larkin (2013), I contend that the subjectifying work that these technologies perform is, in fact, infrastructural work (Bowker and Star 1999). While in the last chapter I discuss how default features are creating standards without our ever opting in, in this chapter I show how, at the same time, subjects consent to these standards because they are made increasingly comfortable with the life entailed in them. By enrolling subjects in the present, I argue that technologies are assembling a social infrastructure though which an increasingly tracked future becomes possible. This future only works if consumers provide access to all aspects of their lives. Thus, consumers need to be steeped in the logic of optimization such that they consent to this kind of life. What technologies like Fitbit do without working, then, is secure
not only consumer consent with but also consumer desire for a tracked and surveilled life. They thus lay the groundwork for the future by making subsequent products thinkable and render an entirely tracked life self-evident.

In this section, I first describe some tactics that consumer health and wellness technology companies have used to convince consumers to opt in to their devices. I then describe how many of my participants who are developing new technologies in this sector consider this kind of enrollment, which is already widespread, to be a critical gateway to a future in which all aspects of consumer life can be tracked.

Designing Closeness & Consent: Creating the Popcorn

The companies that develop consumer health and wellness technologies design these devices to draw consumers in and, in some cases, to cherish their relationships with their devices. Nora, a marketer at a leading wearable company, explains how the design of her company’s devices invites users to feel attached to them. She calls this her company’s “popcorn,” meaning a critical selling point for consumers. Identifying the “popcorn” is common marketing language for understanding what drives consumers to your device and refers to the idea that people are driven to go to the movies for the (buttery, salty, often addictive) popcorn rather than to see a film:

I think people get attached to them [wearables] too because they wear them on their body and they tell them something. For ours [product] the fact that they light up, they bring people joy. When people lose them they're just heartbroken. Do you have any objects that you just get attached to? It's like a personal item in a very different way [from other personal items] and you kind of just get attached to it. Sometimes when I really want like a thing I'm like, "Oh, I've adopted it." I think people just get emotionally attached to them.
Nora points to the intimacy that these technologies are designed to foster and produce for consumers, which allows the company to access the intimate and quotidian activities of consumers’ lives. Critically, as the ‘popcorn,’ these appealing design features draw consumers in, whether or not they are interested in self-tracking. Once these consumers opt in, however, they enroll themselves into the lifestyles these devices entail. As Nora indicates, these devices create attachments, so much so that consumers are “heartbroken” upon losing the device\textsuperscript{87}, as though they have lost a part of themselves because they have “adopted” these technologies.

Lyra, a founder of another set of health and wellness devices, is designing her product specifically to foster emotional attachment, what she calls “emotional triggers,” to keep consumers engaged, so that the company can continually collect data. These triggers include congratulatory and encouraging messages that are design to commend and inspire the consumer to achieve their activity goals. As described in the last section, many companies use these emotional strategies—nudges—to encourage consumers to adopt and stick with a tracked life and thereby maintain the company’s access to consumer life. By regularly providing consumers with rewards for completing certain tasks, such as drinking enough water, Lyra’s devices produce “a feeling of completeness, of being congratulated, the instant gratification” to “emotionally affect [our consumers] in some way” so that they keep using the product.

Consumer health and wellness technology companies need to make incredible surveillance feel palatable and justified so that consumers consent to continuously producing data and an increasingly tracked life. By making these devices feel “personal” and gratifying, these companies make surveillance feel like it is for you. These design strategies become the popcorn that ease consumers into the lifestyle that these technologies require. Drawing on Althusser (1971), I also contend that consenting to increasingly datafied life is made to feel free
(feel like a choice) by feeling *fun*. For example, Nora argues that the duality of utility and entertainment is a critical feature of her company’s devices:

> [Our devices provide] an objective measurement…[of] your activity levels and we're going to put it in something that doesn't look totally ugly. We're going to give it to you in something that's really pretty and has a fun, joyful feature built into it like the blinking light. It’s like, "Oh, cool. I get some function. I get some fun."

These technologies are designed to be simultaneously entertaining, convenient, and useful, rendering opting for life optimization completely seamless. Informational capitalism entails a different kind of labor (and therefore exploitation) than other forms of capitalism (e.g., productive capital) (Andrejevic 2013; Scholz 2013). As Scholz (2013) and Andrejevic (2013) explain, informational capital in part requires subjects who work without feeling like they are working. These are subjects who produce through their own consumption (also known as prosumption). I argue that these kinds of technologies exemplify this type of labor activity and therefore facilitate this form of capitalism because it produces consumers who work—who willingly produce data constantly—purportedly *for themselves* and *for fun*. Consent to an ideology of life optimization and continuous, datafied surveillance is therefore produced and maintained through self-subjection that feels simultaneously entertaining and personally valuable.

*Laying the Groundwork: Establishing the Gateway to the Future*

For my participants, the current iterations of these technologies introduce and acclimate consumers to a lifestyle of continual health and wellness tracking. Many of the founders I spoke with considered major wearable companies, such as Fitbit, to be itself a critical gateway into their products because of the lifestyles these companies have made available, thereby performing critical social infrastructural work. By making these kinds of subjects available, these companies
are setting up the architecture for how these kinds of subjectivity can become increasingly widespread; making such subjects possible and these subjectivities desirable is critical to the promise of these technologies. In what follows, I show how new startups consider these ‘early stage,’ pioneering wearables to have assembled the infrastructure through which subsequent technologies in the consumer health and wellness technology sector become possible and even thinkable. In the epigraph of Chapter 3, I showed how Fitbit claims that it has a “history of inventing the future.” In this chapter I contend that this claim is in part based on what my participants see as the company’s ability to propagate and normalize the subjectivities required for people to live in the Fitbit future—in part because these subjectivities are already widespread in the Fitbit present.

According to founder Lyra, these pioneering companies have made opting in to optimization not only easy but appealing, in part because consumers are encouraged to recognize themselves as self-optimizers who have always already needed these tools:

Smartphones, Fitbits, smartwatches, the idea of having something have a permanent real estate on your body, some sort of technology. Now that that's ingrained, you can go ahead and start filling up the rest of the real estate with things that help people. For one thing it's commonplace [to have a wearable], and so you don't have to be an early adopter, you don't have to be bold. For another, it's just that they[consumers] think of it. You have to have the buying cycle where people are like, "Man, I have a need. I'm going to look for something that fulfills this need," and then actually do the things that get them to your selling page or to your storefront or whatever. People do that now because they think about technology as a way of solving their problems. [Fitbit opened the door for] two reasons: one is that the technology has embedded itself in people's lives, and two, because it is now part of the mind, the thought process, it is able to lead to sales. Both of them allow the other to be true.

These companies, even in their ‘early stages,’ as described in the previous chapter, have made the notion of wearing and living with technologies possible, available, and desirable to consumers. They have normalized the idea that technologies can and should be worn at all times
for continuous data collection to achieve better health. They have habituated consumers to the
idea of living this way, so much so that she thinks these ideas have already become “ingrained”
in the mind of the consumer. According to my participants, part of how Fitbit invented the
present was by creating a market that normalized these devices. As Lyra points out, Fitbit has
laid the groundwork for the future it is already inventing by rendering their devices so ubiquitous
and mundane that consumers already think of and through these technologies.

In so doing, these companies have “opened the door” for her company and others, newer
wearables to enter the market. She argues that Fitbit “created a new need,” and therefore a new
market. However, what Fitbit has done is created a product and a lifestyle that they have
constructed as something that consumers have always already needed but lacked the technical
means to fulfill. In so doing, Fitbit and even smartphone companies have interpellated consumers
by encouraging them to (mis)recognize themselves as the subjects—as life optimizers—who
have always already needed these tools, thereby securing consent to the Fitbit present and future.
By looking to technology to “solve their problems,” these consumers recognize themselves as
problems requiring continuous technical intervention.

Moreover, as Lyra indicates, these companies have normalized these subjectivities so
much so that consumers no longer need to be “bold” in adopting these technologies and their
attendant lifestyles because they have already become socially acceptable. These sentiments are
echoed by Elliott, who works at one of these pioneering companies. He argues that not only did
companies like his make the idea of a passively optimized, datafied life possible, but they gave
consumers the “social permission” to take up these technologies in their daily lives. In so doing,
founder Mason argues that these pioneering wearables have “taught us what a fitness tracker
was” and have therefore become “a de facto kind of thing.” These wearables have done
important instructive and educational work to expose and acclimate consumers to an increasingly normalized tracked life. The fact that these devices, according to Mason, have become “de facto” technologies means that these companies have created the conditions for additional consumer health and wellness technologies to become widespread because the lifestyles entailed therein are already taken for granted.

This is reinforced by founders who argue that their companies would not have been imaginable (or fundable) without what they see as the pioneering efforts of companies, like Fitbit, who have begun to lay the social infrastructure through which subsequent tracking companies make sense. For example, Cecelia, the founder of a company working on an internet connected device to measure and encourage water consumption, says that her company would have sounded ridiculous to consumers (and likely to investors as well) even five years ago:

Since Fitbit and the invention of wearable activity trackers, people are much more open to the quantified self because now at least there is something that would allow them to track. I think if we launched [our company] five years ago, people would think we were silly or out of our minds. "What the hell are you doing?" Right? We do predictive analysis so we know when are you are going to work out and how much water you should drink before work out. If we launched five years ago, people would say, "why are they tracking [that]? Why are they doing that? It's so silly." But now, we can think about it. Now, we understand.

Cecelia argues that the very idea of the products that she is developing only make sense in light of and because of the groundwork already laid by Fitbit and other wearable companies. These subsequent technologies are only conceivable because the ideologies and lifestyles entailed have already been laid down and taken hold in consumer consciousness. Moreover, Cecilia points to how companies like Fitbit have convinced consumers to value tracking such that they might be more open to additional tracking beyond what Fitbit offers. These pioneering companies have made the idea that all aspects of life require tracking and technically-mediated measurement
make sense and feel desirable. In propagating these subjectivities, this sector has made subjects for whom, in their constant quest for optimal optimization, having an entirely tracked life feels necessary, like something they have always already needed.

**Manufacturing Consent**

Ivy, who works in marketing at a leading wearable company, similarly argues that consumers had to be made more comfortable with increasing imperatives to share private, personal data with consumer electronic companies and websites:

People have become more and more open to sharing data. I think for example, on Facebook, people used to not want to share stuff, and then look at people now. People used to be freaked out about [geolocation sharing], but now everyone's just like, find your friends' thing that's out, that's kind of creepy, but you're like, okay. Five years ago it was way more creepy. I think that it's just people getting used to it. That's the evolution of how people accept technology or different aspects of technology. The data is going to be out there. No doubt. It's not even a question of, "Hey, let's stop doing this," it's more about, how do you make sure people are comfortable with what they're doing and no one is using it in a way that's to harm them? I think it's just [that] people adapt to it. Then it becomes like second nature to you after a while and then it doesn't look weird or seem weird to you anymore. Then you're okay with it. You see other people doing it, so you're like, that's fine. I think it's more just people adapting to it and changing their mentality of what's okay and not, it does evolve. There are different people probably that don't like sharing their step counts because they think it's something personal, but the fact that people will get a device, they've already said, "Okay, that's fine for someone, somewhere to be collecting my data."

Ivy describes how technology companies make consumer comfort evolve with their platforms in ways that feel natural because these companies carefully and gradually build this evolution into the devices and apps consumers regularly use. Using examples from social media platforms, she describes how this evolution is careful, quietly integrating ‘features’ into technology such that consumers acclimate and consent to the new data-sharing standards incrementally. As consumer health and wellness technologies proliferate and IoT becomes more widespread, consumers will need to be made more comfortable with and consent to increasingly tracked life. Here, Ivy
illustrates that these companies count on making consumer comfort evolve through quiet standards, which in part works because these technologies—particularly smartphones—are already so embedded in quotidian consumer life.

Ivy argues that this evolution makes it impossible and unnecessary to articulate whether or not we should stop sharing data. Once consumers acclimate to the new standards set by the technologies, she claims that the lifestyles entailed by these devices come to feel natural and unproblematic, like “second nature,” as though it has always been this way. Convincing consumers to participate in the lifestyles entailed by these technologies thus requires continually influencing their “mentality” towards data sharing such that they consent to increased tracking. As Ivy indicates, because subjects are already becoming steeped in the ideology of these technologies, by the time they opt in, they have (always) already consented to the life (and data sharing) entailed by these devices. Through the quiet creep of data-sharing standards, these imperatives are made to make sense and feel like common sense.

According to Gramsci (1999), social relations are maintained through the production of consent with those relations, which is made possible in part through what he calls “common sense.” To Gramsci, common sense is formed through everyday experience, rather than from formal ideas people receive through social institutions, such as schools, and results in a “popular conception of the world—what is unimaginatively called ‘instinct’” (Gramsci 1999:433). Thus consent to the relations of production is maintained through ideology that comes to feel natural, instinctive, and self-evident. Drawing on Gramsci’s notion of common sense, I contend that these pioneering wearables have created the conditions for the proliferation of consumer health and wellness technologies because they have installed and established their logics and subjects as normal—they feel unproblematic. Consent to the kind of life these technologies require is thus
established through the propagation of an ideology that feels natural, through technologies that are carefully constructed to feel self-evident. This allows subsequent technologies being developed in this sector to feel like natural extensions and evolutions of the lifestyles that companies like Fitbit and Jawbone have already established as normal. By interpellating consumers into new markets for new needs that these companies convince them they always already had, the ‘early stage’ technologies have created the ideological infrastructure for these lifestyles to make sense, such that subsequent technologies in this sector feel comfortable, conceivable, and self-evident. Indeed, the fact that new and different wearables are proliferating on the backs of these now “de facto” consumer technologies is evidence that the ideological infrastructure has already been successfully installed. And because my participants argue that these established wearables created a gateway, they have made it possible for the new iterations of wearables but to build on and extend that ideological infrastructure as consumer comfort and consent continues to (be made to) evolve in ways that grow this market.

MAKING ECONOMIC SENSE

The entailed subjects described in this chapter are propagated in part because they are made to make economic sense. As described above, the era of information capital requires subjects who are willing to continuously produce data for themselves. Constructing subjects who rely on these devices to make themselves legible, to nudge them to better health, and to passively optimize their lives are economic strategies that widen the market for these devices. These strategies are designed to make consumer health and wellness technologies a crucial part of all aspects of life—to make a habit out of their products, as founder Lyra notes, and to facilitate continuous data collection. Founders and investors thus construct their technologies as correcting for human fallibility, but not correcting fallibility itself (which they view as irreparable), as a
way of extending their market potential. The work these technologies do that justifies investment
in them is that they promise to make all kinds of humans into rational decision-makers who make
the right kinds of decisions—to take a more active role in their health, sometimes by simply
buying into these devices. Such a logic justifies continuous surveillance and technical
intervention. By defining the problem as inherently human and inherently behavioral, they
construct a market for their interventions that is built on a life-optimizing subject that considers
external technologies better equipped to intervene on their poor health behaviors. Thus the way
these actors imagine, define, and intervene on “behavior” has to make economic sense—they
have to define the problem in a way that makes (continuous use of their) technologies vital.
These technologies become vital in as much as they are organized around life, designed to feel
essential to life, and used for life—for one’s whole life and to sustain life.

Additionally, the economic success of pioneering wearables described in the previous
section has created comfort for investors, such that subsequent startups in this sector make
economic sense. Investors take this economic success as evidence that these technologies are
routine enough to make these markets viable, that in turn facilitate their consideration of
financing new technologies that can extend this market. Austin, a founder of a consumer health
and wellness company, explains that getting consumers comfortable with the idea of wearables
has validated these consumer health and wellness technologies as a financial opportunity by
demonstrating that this is a market that can be made in the first place.

Getting people over a comfort barrier is the really important thing [that wearables have
done] and demonstrating that there is financial opportunity, that consumers do care about
their health. You couldn’t go to investors maybe five years ago [or even] before 2014,
person didn’t care at all. Having an IPO, being able to sell these devices to people
demonstrates [that] people do care. They care so much they’ll even buy things that aren’t
necessarily that effective.
The economic success of wearable companies helps make these kinds of technologies self-evident to investors because it illustrates that these subjects have already been made. Before 2014, Austin argues it would have been hard to convince investors that this market is possible because the financial metrics to demonstrate market viability might have been sparse. However, the financial success of pioneering technologies (that do not even work well) demonstrates to investors that consumers care about their health in ways that can be made commensurable with these devices and their platforms. Thus, when I asked Lyra about how to reconcile Fitbit’s financial success with its high consumer abandonment rate and inaccuracies, she argued that “they [Fitbit] were the first wearable to make it onto half of everyone's wrist. I hardly consider that a failure….They had to create the market, and they've had to be the ones that are learning about this consumer base that is growing because of them.” To her, Fitbit’s pioneering work has been to establish a market such that their devices and those of others could proliferate in the first place, thereby paving the way for other technologies to not only make sense to consumers, but also to make economic sense to investors.

CONCLUSIONS

In this chapter I have considered the types of subjects required for and assembled by consumer health and wellness technologies. For Gramsci and Althusser, capitalism requires particular kinds of governable subjects who endure and consent to exploitative relations of production because they are so steeped in ruling ideas that these relations make sense. For them, the production of governable subjects is an economic imperative. Foucault similarly argues that the production of governable, disciplinable, and sometimes self-governing subjects is a precondition of capitalism (Foucault 2010). Thus, Gramsci, Althusser, and Foucault all argue that particular forms of economy require the continuous production of certain subjects. As consumer
health and wellness technologies lay the groundwork for a future in which all aspects of life become tracked, they make up subjects who, in their constant quest for optimization, rely on these technologies to render and make legible their lives and bodies for them. These subjects (mis)recognize the superiority of these technologies to know (them) better and therefore opt into the need for infrastructure that passively optimizes their lives or nudges them into better life. As ubiquitous tracking becomes increasingly standardized in consumer environments and devices, consumers thus also misrecognize their ability to opt in to optimization in the first place. I showed how these kinds of subjects get built into the design of these devices by illustrating the various techniques of active nudging and passive optimization that operationalize these assumptions about subjects. I then argued that by interpellating consenting subjects in the present, consumer health and wellness technologies, particularly pioneering wearables, lay the groundwork for an increasingly tracked future. In so doing, they assemble a social infrastructure that is as essential to the work they perform and their value as the digital and economic infrastructures that I describe in Chapter 3. Lastly, I explored how assembling these kinds of subjects for future is designed to make economic sense, which informs how these technologies develop and the trajectories they are designed to have. These are subjects who make themselves into economic objects in service of their own optimization.

In this chapter, I have argued that subjects consent to an ideology of life optimization and incredible surveillance because it feels like a choice. However, I elaborate that in an era of informational capitalism, subjects consent because freedom feels like fun. These technologies—which are designed to look and feel like consumer toys—create consent through entertaining consumption that feels personally valuable. These useful toys encourage subjects to opt in because they are designed to feel like fun rather than work. By enrolling themselves, these
subjects create a portal through which companies can continuously monitor their lives. Thus, these subjects consent because they work without feeling like they are working. In informational capitalism, where consumption and production become simultaneous, these subjects need to consent to continuous consumption because, in so doing, they allow for continuous production. Thus, the subjects interpellated by these technologies, misrecognize their use of these devices (work) as play and as for them, and therefore consent to unprecedented, continuous surveillance of their activities, movements, emotional states, and bodies. This is the sense in which consumer health and wellness technologies build all around us, and within us, a social infrastructure that creates the means of its own maintenance, extension, and reproduction.

Multiple commentators of infrastructure, such as Star (1996; 1999), Bowker and Star (1999), and Wilson (2016) argue that infrastructure, when it works, becomes seamlessly integrated into the practices it organizes and therefore becomes hard to see. Wilson (2016) contends that infrastructure functions as ideology because it obscures labor and politics as it becomes backgrounded. Its invisibility is sometimes designed to “achieve the status of taken-for-granted” (Wilson 2016:270). In this chapter, I consider for whom this infrastructure is invisible. The social infrastructure may be designed to be invisible to the subjects enrolled in it, but my participants, who are actively capitalizing on and designing from these infrastructures, see it keenly. Startup founders in particular actively acknowledge how critical the assembly of this social infrastructure is to the possibility of their products. At the same time, these infrastructures work by enrolling subjects who cannot see how their own subjection is being erected through their “choices” to participate in these technologies. They are thus simultaneously invisible (to consumers) and highly visible (to designers).
Like Schüll (2016), my findings challenge Lupton’s (2013a; 2014a; n.d.) claims that the subject imagined and produced in these technologies is a neoliberal, enterprising subject who takes over the responsibility of actively managing their health and health risks. Rather the subjects of these technologies are increasingly urged to opt in to outsourcing the work on themselves to choice architecture. Schüll (2016:14) similarly has found that designers of these technologies “position users of self-tracking technology as desiring not to be in charge” and develop their technologies with these subjects in mind—subjects who choose to abdicate their responsibility. This subject is “figured by the wearable tech industry as a passive, choosing self who will want to employ devices to actively help her” (Schüll 2016:14). I would argue that these subjects are *encouraged* to abdicate these responsibilities because it allows them more time for consumption, which, in the era of informational capitalism, becomes simultaneous with production.
SUMMARY OF THE DISSERTATION

In this dissertation I have investigated what consumer health and wellness technologies are, how they have come to exist, the value that investors and founders imagine in them and in the futures they set in motion, and the kinds of subjects they require and assemble to work. One of the main contributions of this research is to trace how investors and startups negotiate and socially construct value on the ground and in practice. It provides a window into the future-building orientation and work of the tech sector and the entanglements of value, infrastructure, and futures in consumer health and wellness technologies. In this dissertation, I take the consumer sector seriously; while others (e.g., Lupton 2014a; 2016; n.d.; Schüll 2016) have not situated these technologies in the context of the consumer electronics sector, by doing so I have been able to foreground how the consumer sector is critically constitutive of these technologies, their markets, legacies, and infrastructures. In this way, I treat the consumer sector as far more than mere context. As I have shown throughout, the fact that these devices and apps are designed by consumer technology companies to be sold directly to consumers has implications for how they are designed to work, their trajectories, and the kinds of subjects they require.

Like Schüll (2016), I heed Lupton’s (2014a) call for sociological scholarship on the tacit assumptions and practices of those who bring these technologies to life and to market. However, following Birch (2016), I integrate financial actors and practices of finance as well to piece together how developers and investors work together to imagine and produce these technologies and, in so doing, assemble and mobilize particular futures. By explicitly engaging investors and placing constructions of multiple forms of value at the center of this research, I complicate how
value is not only constructed in the exchange of data but also in the *possibility* of these data. Thus, rather than assuming that these technologies generate capital (and profit) through the exchange of data, as Lupton (2014a; 2016) has done, I instead turn the construction of value into an empirical question and ask how and why are these technologies imagined to be valuable? This brought into focus the myriad ways that these actors see value beyond the devices and data themselves and revealed the work that these technologies do without working. Through attending to infrastructure, this dissertation considers the intricate infrastructural work (Bowker and Star 1999) that is *already* underway in the consumer technology sector to assemble and make widespread a future in which all aspects of consumer life are continuously captured. In what follows, I summarize the arguments of each chapter, discuss theoretical contributions, consider the implications of this dissertation, and propose directions for future research.

*Key Findings*

In Chapter 2, I described the technical and economic conditions that have made consumer health and wellness technologies and their proliferation possible. The central argument of this chapter is that particular technical developments in consumer electronics—namely wearables and smartphones—and their financing have fundamentally conditioned and shaped the emergence of consumer health and wellness technologies *as well as* the futures imagined in them. In so doing, I situated these technologies within the constitutive context of the consumer electronics sector and its financing.

I began that chapter by describing specific technical advancements, often driven by imperatives for increasingly miniature and portable computing devices, that were critical to the development of both consumer wearable devices, smartphones, and health and wellness mobile apps. In this section, I foregrounded how the proliferation of consumer health and wellness
technologies in the present draws on the legacies of other consumer electronics. I illustrated how Apple and Google’s entrances into the smartphone market in the late 2000s crucially created a way into (and opportunities to datify) aspects of consumer life for the consumer electronics industry. I demonstrated how these technologies, which were always on and always able to collect data, were designed to be relevant to all aspects of life and thereby completely subsumed consumer life. Moreover, the growing ubiquity of sensors in these devices made it increasingly possible to render life continuously, which has become a critical feature of the consumer health and wellness technology sector. I argued that these companies not only created unprecedented access to consumer life, but created a way to render that life continuously as part of their business models.

In the second half of Chapter 2, I explored how equity financing fundamentally structures the development, value and trajectories of consumer health and wellness technologies. I argued that attending to the mechanisms of equity finance is crucial for understanding how these technologies come to be valuable in light of the incredible pervasiveness of failure in the startup sector. By foregrounding equity finance, I considered how and why anticipating future value comes to structure how technologies becomes valuable in the present. I showed that given the highly uncertain nature of the startup sector, this financing mechanism builds speculation and future promises into these technologies and their value in the present. I contended that equity financing is able to work without working because, despite its failure to predict the future, neoliberal economic reforms allow the stakes of failure to be incredibly low and the benefits of success to be wild.

Chapter 3 explored themes discussed in Chapter 2 in the empirical context of consumer health and wellness technologies. In Chapter 2, I showed how speculation about future value
structure equity financing. In Chapter 3, I examined how value is constructed in the futures that consumer health and wellness technologies make imaginable and the work they already perform in service of those futures. To understand how future value is animated in the present, I considered what I called the “wearable paradox,” wherein many leading consumer health and wellness technologies are plagued with inaccuracies and high user abandonment and yet have witness enormous financial success. Using this paradox as a way into the social construction of value in these technologies, I explored how these devices ‘work without working,’ thereby foregrounding the infrastructural work that these technologies perform, despite not working well. I argued that these technologies lay critical groundwork for an increasingly tracked future, which allows them to accrue value in the present. I contended that these technologies, which investors and founders consider to be in their early stages, are performing myriad forms of infrastructural work, including: creating a portal into a dataset that heretofore did not exist and assembling the groundwork for an increasingly networked future called the Internet of Things by creating data integration standards in the present. This infrastructural work renders consumer life as data through toy-like interfaces and claim to make these data meaningful through integrative practices that standardize both data collection and data integration practices in the process. I concluded by considering how, in constructing themselves as visionaries that are uniquely positioned to envision and invent the future, these companies and their investors are laying the groundwork for a future in the present so that their decisions about how to measure, know, and capitalize on consumer life are standardized by the time we arrive.

While Chapter 3 focused on the economic and digital infrastructures that consumer health and wellness technologies assemble in the present in service of the future, Chapter 4 focused on what I called the “social infrastructure” of these technologies. Drawing on Gramsci, Althusser,
and Foucault, I explored the subjects that are both required and produced by these technologies and considered how consent to the incredible surveillance they effect is maintained. Following Stuart Hall (1986:29), this chapter explored how these technologies come to “grip the minds” of consumers such that they consent to their own subjection. In this chapter, I argued that rather than assembling markets of people who choose to consume these technologies, founders and investors of these technologies require, imagine, and produce subjects who consent to and live through an ideology of life-optimization, such that they are always already available as a market. To illustrate these arguments, I described the subjects that are entailed—as in, simultaneously implied, required, and produced—in the design of these devices. I contended that these are subjects who: 1) are life optimizing and rely on these devices to make themselves legible (to themselves and others), 2) recognize their own need for nudging, and 3) seek optimal optimization and therefore choose to abdicate their own work on themselves to technologies that will modify their lives on their behalf. These are subjects who are not just seeking to stave off illness or health risks but who also seek optimal strategies for continuously engineering a better life. In this quest, they (mis)recognize their own inferiority for objectively knowing their bodies, motivating themselves, and optimizing their lives.

I subsequently argued that by enrolling these subjects in the present, consumer health and wellness technologies are assembling a social infrastructure though which an increasingly tracked future becomes possible. Drawing on themes from Chapter 3, I further contended that the work technologies like Fitbit perform without working is to secure consumer consent with and desire for a tracked and surveilled life. These technologies therefore lay the groundwork for the future by rendering an entirely tracked life self-evident. Lastly, I showed how imagining, producing, and entailing these subjects as the social infrastructure are economic strategies that
widen the markets for these devices and are designed to facilitate continuous data collection for the companies developing these tools. In this chapter I illustrated how these technologies build with subjects, creating consumer health and wellness around and within us. These tools thereby assemble the social infrastructure through which increasingly tracked life reproduces itself.

THEORETICAL CONTRIBUTIONS

I opened this dissertation with a question: how did the iPhone become a health device? I have shown that consumer health and wellness technologies have already and continue to lay the groundwork for a future in which these devices take hold in the quotidian fabric of consumer life. As sensors in consumer devices, especially smartphones, become default features, it is clear that this process is already well underway. Lupton (2013b) has argued, these technologies are co-constituted with neoliberal imperatives for personal health responsibility, through which self-tracking becomes expected. Lupton (2016) and Schüll (2016) argue that developers’ and entrepreneurs’ efforts to capitalize on self-tracking practices have spurred the development and proliferation of smartphones and wearables as health technologies.

But this dissertation has also argued that there are other dynamics at play. Consumer technologies have been in the business of tracking consumers for decades (e.g., loyalty cards, browser cookies) (Cohen 2015). Consumer data were already economic objects. The iPhone became a health device because, in fact, it always already was one—Apple just did not advertise it as such until 2014. As I show in Chapter 3, the groundwork for a smartphone to become a health device was set in motion years ago, when these companies claim to have invented the present. Thus, by the time consumers become aware of these capabilities, these decisions—now standards—are made to feel self-evident, especially because technologies like the iPhone have already inserted themselves into all aspects of consumer life. A critical part of this groundwork,
as described in Chapter 4, is creating the kinds of subjects that consider these tools to be for themselves. These subjects are paying to be capitalized, consenting to the continuous capture of life itself, in search of optimal optimization. The groundwork that these consumer health and wellness technologies perform assembles the infrastructure of the future in the present, such that a smartphone health device both *feels* like something consumers always already wanted *and feels* like a choice. Thus, the iPhone has become a health device because the social and economic infrastructure has been installed such that it is possible, desirable, and self-evident for consumers to turn their health and life into private assets all by themselves.

*Financializing Life Itself*

I argue that these technologies effect a financialization of life itself. In their theory of biomedicalization, Clarke and colleagues (2010) argue that life has become commoditized and corporatized and that life itself is increasingly capitalized. However, in their description of risk and surveillance, they also argue that health has become a never-ending project of risk management that justifies and rationalizes continuous biomedical interventions—for life. As I have shown, consumer health and wellness technologies exemplify this process of biomedicine, as they seek to continuously capture consumer life in the name of wellness. However, this suggests an *assetization* of health (and, indeed, life), not a commodification. This is because assetization involves “the transformation of something into property that yields an income stream (and not a commodity for sale)” (Birch 2016:9). Assets do not have to be material or “tangible” to be capitalizable and tradable (Birch 2016, Birch and Tyfiled 2013). In the case of consumer health and wellness technologies, all aspects of consumer life become datafied by these technologies. These data are captured, aggregated, and stored by private companies, such as Google and Fitbit, not necessarily for exchange (though that is possible) but to accrue value
through the knowledge that can be amassed (and the analytics that can be run) about the individual and the population. Because these technologies are assembling the future—and our future selves—in the present, life thereby becomes a way to generate capital over and over again, indefinitely into the future, and this value only grows as consumers continue to use these devices, another feature of an asset (Birch 2016).

As I discussed in the introduction, I assumed I would access the value and valuation of these health data through the sale or exchange of data (e.g., between a company and data brokers). However, as assetization points to, investors and founders can construct value in technologies in myriad ways that do not explicitly involve the sale of data or profit. The data that these technologies make possible can accumulate value for companies as a form of property that enables a particular kind of both individual and population-level knowledge. Moreover, I have shown that investors and founders see value in infrastructural work. I argue that these technologies are assembling the digital, economic, and social infrastructure through which consumer life can be assetized.

Lastly, following how capital moves through these technologies epitomizes a logic of financialization because, as I have shown, these technologies are not only valuable for how they work in the present. Rather, these technologies are considered valuable for their vision of the future and the future that they set in motion in the present. Financialization signals a larger shift away from productive capital, wherein the commodity is the major source of accumulation, to finance capital, wherein assets, investments, and forms of speculative finance (i.e., capital markets) dominate accumulation (Jameson 1997; Krippner 2005; 2011). As is typical in financialization, consumer health and wellness technologies become valuable through the speculative claims the companies who develop them make on the future. In so doing, these
technologies provide an entry point for capital markets, and their financialized logics, to colonize consumer life. Leyshon and Thrift (2007:98) argue that this “constant searching out, or the construction of, new asset streams” is a hallmark of financial capitalism, a claim which Jameson (1997) shares. The advent of technologies that could make all moments of consumer life capitalizable thus become realized through financial instruments for financial ends. This is part of a larger trend of expanding definitions of what constitutes a “reliable income-yielding asset” (Leyshon and Thrift 2007:100). If equity financing is considered an experiment on the future (see Chapter 2), then these experiments test the viability of consumer life as an asset.

In this culture of finance, Blacker (2014:129) and others have argued that “our work and everyday lives” are increasingly organized around financial logics, where “a range of issues we face, from social cultural, scientific, and medical realms, are considered in relation to investment, debt, and propensity for growth and expansion.” This is not just a capitalization of life itself, but a particular financial orientation to society and life itself that leverages financial notions and practices of speculation, derivation, and investment to locate opportunities for and streams of continuous capital accumulation. In this context, consumers are increasingly encouraged to literally and figuratively invest in their own health and productivity through consumer and biomedical technologies and the governance they effect (Blacker 2014). What this dissertation demonstrates, then is how the development of consumer health and wellness technologies are both situated within and extend these larger trends by transforming life into a continuously capitalizable asset—for life.

_Theorizing Infrastructure as Capital_

This dissertation also weaves together theories of infrastructure with theories of capital. While multiple commentators, such as Bowker and Star (1999), Star and Ruhleder (1996), and
Murphy (2013a)(2013) have elucidated the ways that infrastructure encodes and embeds politics, values, social relations, and can effect and amplify stratifications, far less attention has been paid to how the assembly of digital infrastructures are increasingly significant economic projects. These infrastructures are big business, and not only allow capital to flow but themselves generate billions of dollars for private companies, particular in the technology sector. The five most valuable companies in the U.S. by market capitalization\(^{89}\)—all technology companies for the first time in U.S. history—can be said to be in the business of building and maintaining information infrastructure. Much of their combined $2.45T in value, particularly for companies like Google and Facebook, stem from the pervasiveness and ubiquity of these infrastructures in consumer life. Additionally, as economic projects of private companies, erecting these digital infrastructures is typically not a transparent process for consumers. As Star (1999) has argued, infrastructure is often invisible when it works and Wilson (2016) contends that infrastructure’s invisibility allows it to function as ideology by masking the labor and politics that are critical to its assembly and maintenance. I have shown how these digital infrastructures are strategically invisible to consumers, but highly visible to founders and investors who see value in their assembly. Indeed, these digital, economic, and social infrastructures are designed to be sunk into consumer’s quotidian practices such that we do not even know that they are there. And, as I contended in Chapter 3, these infrastructures are assembled in the present to invent and build the future, such that founder’s and investor’s design decisions are standardized by the time consumers arrive in that future (e.g., the iPhone health app). In these ways, the invisibility of these infrastructures is critical to how founders and investors produce consent and make their futures feel self-evident.
Moreover, Leyshon and Thrift (2007:101) argue that, in this era of financial capitalism, infrastructures have become assetized as “predictable and secure income streams” in part because of their “quasi-monopolistic relationship with [their] consumers.” Though Leyshon and Thrift (2007) focus on physical infrastructures, such as waterways and highways, I would argue that information infrastructures are equally constituted by this logic. By elucidating how investors and founders construct value in the work of assembling the social, economic, and digital infrastructure, this dissertation therefore contributes to theories of infrastructure by exploring not only the values embedded within infrastructure but how continuous value is imagined through it. Infrastructure is not just a conduit for capital, but a critical financial asset in and of itself, through which further assetization (of life itself) is made possible.

In these ways, I bring together theories of infrastructure, finance capital, subjectivities, and information to consider the myriad forms of work that consumer health and wellness technologies perform without working. These technologies and the financialization they effect are a window into the work of contemporary capitalized infrastructures. Moreover, as I show in Chapter 3, these technologies are already standardizing particular practices of datafication, such as the pervasiveness of default, continuous consumer activity tracking in smartphones. Through these standardizations, the grammar of life—what can be articulated about life, its value, and its metrics—are also becoming standardized, such that it becomes increasingly impossible to imagine how things could be otherwise (Dumit 2012; Hughes 1971; Sunder Rajan 2006).

*The Biopolitics of Venture Capital*

This dissertation also considers how venture capital can be considered a biopolitical technology. In his theory of biopower, Foucault (1990) argues that the modern state can be characterized by a generative regime of power exercised at the level of life. He argues that bio-
power signals a transformation in the mechanisms and operation of power, from a sovereign power characterized by a power to cause death, to a regime of bio-power characterized by the power to administer, organize, manage, and invest in life. He proposed a bipolar model of bio-power: a dual intervention of this regime of power on the individual body, known as anatamo-politics (a power that both individuates and operates at the level of the individual), and on the population, known as bio-politics (a power that is concerned with the life of the population as a kind of body that is critical to the continued life of the state). Biopolitical technologies treat the population as a body whose life is invested in to secure the future of the state, thereby rendering life at the level of the species “the object of systematic, sustained political attention and intervention” (Foucault 2010:17). Under biopower, “the problem of health of all” became “a priority of all” and “the health and physical well-being of the population” became “one of the essential objectives of political power” (Foucault 2010:275, 277).

I have shown throughout this dissertation that venture capitalists advance capital to consumer health and wellness technology companies because they see value in the kinds of futures that these technologies make imaginable, even if some of these technologies fail or fail to work well. It matters that these are health technologies through which the future is being envisioned, speculated on, and assembled. In advancing this kind of capital to companies that are in the business of rendering life, venture capital becomes a biopolitical technology that seamlessly aligns the health of the (venture) fund with the health of the population and the health of the individual. This is effected through the production of particular subjects—a form of governance that works from “the inside out” by creating subjects who “work on themselves…in the name of (individual and collective) life and also health” (Clarke et al. 2010:78; Lemke 2011:120). However, rendering the health of the individual and population commensurable with
the health of the fund requires certain kinds of subjects to *secure* the future of the fund (through *securities* that anticipate future capital flows). This is a particular kind of investment in and governance of life through which investors—through their technologies—become critical “authorities” on life (Lemke 2011). Through these investments in infrastructure-laying technologies, subjects are quietly engineered to produce their life as an asset—thereby increasing their own productivity in their consumption. In this way, like Murphy (2013b:140), I argue that this form of investment “engineer[s]” the population “toward future economic progress.” In this case, as I have illustrated in Chapter 4, subjects cannot be trusted to secure the future of the fund on their own—their lives are invested in through and through by opting in and “actively appropriating” continuous surveillance for life (Lemke 2011:120). Moreover, by financing the assembly of these intricate (and interwoven) social, economic, and digital infrastructures, investors secure these subjects (and their governability as subjects)—as investments—by securing the future.

**IMPLICATIONS**

This dissertation offers several implications for medical sociology as well as for policy. First, I have demonstrated how the *consumer* sector is increasingly in the *business* of measuring, managing, and monitoring health. Health is no longer limited to the clinic or the lab, but has extended into consumer objects, including vehicles, home appliances, jewelry, and phones, as well as consumer spaces, such as the home. Moreover, throughout this dissertation I demonstrated how the consumer sector is critically constitutive of these devices: the fact that they are *consumer* devices shapes how they are designed, how they measure health and life, the infrastructural work they perform, and the futures they imagine and make possible. Thus, this research urges medical sociologists to take the consumer sector and its implications seriously as
a site that is increasingly and actively involved in the production, circulation, and measurement of health and life.

Additionally, with the rise of consumer health technologies and the consumer sector’s involvement in health, equity finance is becoming equally as important in the assembly of these forms of health and health infrastructures. I have shown throughout that the logics of equity finance and its temporality fundamentally affect how these technologies are imagined, the work that they are designed to perform, and the infrastructures they assemble. This increased financialization of health, where health and life become assets, is not only made possible through these technologies but, in the infrastructures they assemble, these processes will be extended as life becomes progressively tracked. It is therefore equally crucial for medical sociologists to consider the role and logics of equity finance in the contemporary (and future) production and management of life.

In Chapter 3, I illustrated how consumer health and wellness technologies, as equity financed devices, are assembling the future in the present. I argued that much of the work that these technologies perform in the present sets in motion a future in which all aspects of consumer life are continuously tracked. I therefore argue that sociologists and policy makers must investigate the claims these companies and their investors make on the future because, through infrastructures they assemble, they quietly standardize their designs by the time consumers arrive in their future. Thus, sociologists and policy makers must examine and critique these infrastructures while they are being assembled and negotiated, in order to be able to intervene on their standardization and institutionalization.
FUTURE DIRECTIONS

This dissertation points to several opportunities for future research. First, though this dissertation primarily explored technologies that are sold directly to consumers, corporate wellness programs are an increasingly significant source of revenue for these companies that produce these devices, including Fitbit and Misfit Wearables. Fitbit alone is projected to earn $180M in 2016 from sales to employers (2016). In many of these programs, employees, who often receive insurance coverage from their employer, receive insurance premium discounts based on tracked user behavior, such as activity levels. As these trends continue, further research is needed to understand how these technologies and their infrastructures are being deployed in these contexts and the surveillance they effect. Moreover, might consumer health and wellness technologies produce and require particular workers and become metrics for productivity? Are these companies using these data on employees and what value are they understood to have, and if so, how? What kinds of infrastructures are these technologies assembling in their deployment as workplace wellness products? This dissertation has explored myriad forms of work that these technologies perform, and corporate sponsorship of these devices presents another context in which to explore the work, value, and implications of these devices as they proliferate in the U.S. market.

Consumer health and wellness technologies may also be eliding the distinction between consumer and medical technologies. While I have focused on these devices as consumer technologies that are designed to seamlessly integrate with consumer life, Misfit Wearables, Fitbit, Lumosity, and several other consumer health and wellness technology companies are performing clinical trials in order to become reimbursable by insurance companies as medical devices. This will allow them to straddle the line between and even elide consumer technology
and medical devices. Indeed, some of these technologies are already offered by insurance companies to policyholders. For example, Oscar, an insurance startup that has raised $727.5M in equity financing, provides policyholders with Misfit Wearables. When Oscar policyholders achieve certain activity levels based on tracked behavior, they receive gift cards to Amazon.com. These devices are increasingly being used for data collection in clinical research to monitor patient/participant behavior—indeed the UCSF Committee on Human Research application now includes an option to collect data from wearable devices for research purposes. Future research should investigate how and why these technologies—especially given evidence of their inaccuracies (see Chapter 3)—are becoming clinical and research tools; what are the implications of integrating these technologies into biomedicine? As these technologies elide the consumer sector with biomedicine, what implications does this elision have for how we theorize biomedicalization?

Lastly these technologies are being developed in societies rife with stratifications and may be implicated in their reproduction and even extension. Research is emerging on the stratifying effects of Big Data, from the financial sector to healthcare. For example, Lerman (2013) cautions that in an increasingly datafied world, populations that are strategically excluded from datasets due to existing inequalities may be further marginalized by policies and practices built from those datasets. O’Neil (2016) variously describes how Big Data has been used to develop targeted, predatory advertising to exploit vulnerable populations (e.g., for for-profit degree programs and payday loans); predictive policing models that target and intensify unequal surveillance of racial minorities; and creditworthiness scoring that draw from web browsing data, zip codes, user location data and a variety of other so-called digital exhaust to unfairly determine bank lending practices. As consumer health and wellness technologies become critical sources of
continuous behavioral data, future research must explore how these data may become integrated into these already exploitative and stratifying practices as well as create new forms of inequality. For example, how might corporate wellness programs that employ fitness tracking devices privilege particular bodies and activities over others? How might life insurance companies use these data to determine whom to insure and whom to exclude? What populations are being excluded from these technologies and therefore the predictive analytic models they are developing? Consumer health and wellness technologies focus almost exclusively on individual behaviors and neglect structural conditions that determine and stratify health, illness, and risk, further individualizing health and health responsibility. Given how quickly these technologies are already proliferating, research that explores how these technologies may reproduce and even exacerbate existing social stratifications in and beyond health is sorely needed.

CONCLUDING THOUGHTS

This dissertation has examined the emergence, proliferation, valuation, and futures of consumer health and wellness technologies. By studying the investors and startups that bring these technologies to life, I situate these technologies in the consumer electronics infrastructures and markets through which they have become possible as well as the economic logics through which they are made valuable. In so doing, I have attempted to explicate the myriad infrastructural work that consumer health and wellness technologies perform to quietly assemble an increasingly tracked future. I have argued that equity finance, these technologies, and their subjects work without working: first, equity finance runs on routinized and spectacular failure that largely benefits investors; second, leading wearable vendors like Fitbit sell products plagued with inaccuracies and yet are worth billions of dollars because they assemble the infrastructure of the future; third, the subjects entailed and enrolled in these technologies consent to incredible
surveillance in part because their digital labor *feels* like fun rather than work. Consumers are failed over and over again by these disciplining, individuating, and inaccurate technologies that fail to measure the structural conditions that produce health and illness. They are failed by a sector that encourages consumers to buy into devices that are purportedly *for themselves* but effect an assetization and financialization of their lives over and over again. As particular forms of consumer life get built into the infrastructure of the future, an infrastructure that *already* circulates billions of dollars in private capital through financial instruments and technologies that do not work for society, investors and founders lay the groundwork for a future in which consumers have always already lost.
# APPENDIX A: SUMMARY OF PARTICIPANTS

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Occupation</th>
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<tbody>
<tr>
<td>Rakesh</td>
<td>Founder of Health and Wellness Tech Company (Co-Founder with Kyle)</td>
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<td>Anjali</td>
<td>Founder of Health and Wellness Tech Company</td>
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<tr>
<td>Vir</td>
<td>Founder of Health and Wellness Tech Company</td>
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<tr>
<td>Kyle</td>
<td>Founder of Health and Wellness Tech Company (Co-Founder with Rakesh)</td>
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<td>Curtis</td>
<td>Founder of Health and Wellness Tech Company</td>
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<td>Heather</td>
<td>Founder of Health and Wellness Tech Company</td>
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<td>Aaron</td>
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<td>Spencer</td>
<td>Founder of Health and Wellness Tech Company</td>
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<td>Corey</td>
<td>Founder of Health and Wellness Tech Company</td>
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<tr>
<td>Owen</td>
<td>Founder of Health Information Technology Company</td>
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<tr>
<td>Mason</td>
<td>Founder of Health and Wellness Tech Company, Former Government Official</td>
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<tr>
<td>Ethan</td>
<td>Founder of Health and Wellness Tech Company</td>
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<td>Gayatri</td>
<td>Founder of Health and Wellness Tech Company</td>
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<td>Miles</td>
<td>Founder of IoT Tech Company</td>
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<td>Austin</td>
<td>Founder of Health and Wellness Tech Company</td>
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<td>Nikhil</td>
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<td>Lyra</td>
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<td>Cecilia</td>
<td>Founder of Health and Wellness Tech Company</td>
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<td>Glen</td>
<td>Founder of Health and Wellness Tech Company</td>
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<tr>
<td>Chad</td>
<td>Director of Strategic Alliances, Health and Wellness Tech Company</td>
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<tr>
<td>Abbey</td>
<td>Business Development &amp; Marketing, Health and Wellness Tech Company</td>
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<tr>
<td>Reed</td>
<td>Data Scientist, Wellness Tech Company</td>
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<td>Vinay</td>
<td>VP Technology, Health and Wellness Tech Company</td>
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<tr>
<td>Kaushal</td>
<td>Sr Engineering Manager, Founder of Health and Wellness Tech Company</td>
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<tr>
<td>Nora</td>
<td>Director of Communications, Health and Wellness Tech Company</td>
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<tr>
<td>Ivy</td>
<td>Marketer, Health and Wellness Tech Company</td>
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<td>Elliott</td>
<td>Marketing Director, Founder of Health and Wellness Tech Company</td>
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<td>Aditya</td>
<td>Angel Investor</td>
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<td>Dylan</td>
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<td>Randall</td>
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<td>Kiran</td>
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APPENDIX B: REGULATORY ENVIRONMENT

The regulatory environment for consumer health and wellness technologies is exceedingly complex but critically conditions their development and how capital flows through them. Many of these technologies, such as wearable activity trackers, are considered “general wellness” technologies because they do not provide diagnostic or therapeutic information. The Food and Drug Administration (FDA) separates these general wellness technologies into two categories: those that reference disease conditions and those that do not. Technologies that fall into the latter category and do not provide diagnostic or therapeutic information are automatically considered general wellness technologies. Technologies that do reference disease conditions are considered general wellness technologies if they claim to be part of a “healthy lifestyle” that is “generally accepted” (i.e., through peer-reviewed scientific publications) to reduce the risk of a certain condition or help a consumer to live well with such a condition (U.S. Food and Drug Administration 2015). According to the FDA, the general wellness categorization should only be applied to technologies that present low risk\(^{90}\) to consumer’s safety. Many economically successful consumer health and wellness technologies, such as activity trackers, apps for “cognitive training,” calorie and activity trackers, and mindfulness, are considered general wellness technologies and are therefore exempt from FDA regulation as medical devices.\(^{91}\) Instead, these companies are generally regulated by the Federal Trade Commission (FTC), which protects consumers from fraudulent and deceptive business practices. The FTC, among other things, monitors data collection, exchange, and sharing practices of these companies, as well as any claims these companies make about product effectiveness.

As wellness technologies, many of the devices discussed in this dissertation are exempt from FDA regulations. The companies that develop these technologies do not have to raise as
much capital to bring them to market, as they do not have to demonstrate product efficacy through capital-intensive clinical trials. Thus, these FDA-exempt technologies proliferate in part because they are much cheaper and easier to develop relative to an FDA-regulated medical device, for example. These companies generally market their products directly to consumers and do not need to partner with health systems, providers, insurers, or hospitals to bring their products to market. Additionally, as I describe in Chapter 2, investors tend to specialize: those who work with consumer products and consumer IoT do not typically invest in so called “FDA-pathway” devices and services, as these sectors require different expertise. Thus, the financing mechanisms are directly related to the regulatory environment.

While some of these devices are not regulated by the FDA as medical devices, some are covered by the Health Insurance Portability and Accountability Act (HIPAA), which, in these contexts, is enforced by the Office of the National Coordinator for Health Information Technology (ONC) of the U.S. Department of Health and Human Services. Some of these technologies are thus HIPAA compliant, such as Ginger.io, a mental health care mobile app that uses smartphone sensors and self-report data to identify and connect users who may be in need of mental health care to providers. HIPAA, however, is designed to cover certain parties, such as providers, hospital systems, and health plans, as well as their industry partners. Thus, if a consumer health and wellness technology company does not partner with one of these HIPAA-covered parties, they are not required to comply with HIPAA, regardless of the data they generate. This regulatory environment intimately effects how data generated through these technologies move. When these technologies are not required to be HIPAA compliant, the data they collect from consumers, such as heart rate, sleep patterns, and sweat composition, are not considered health information because they are not integrating these data with HIPAA-covered...
entities. This means that these data can move differently because they are treated the same way that other mobile device data (and other consumer data), such as text messaging history and web browsing history, are treated. Many of the companies involved in this study and many of the leading wearables and mobile health and wellness apps are not required to be HIPAA compliant. This means that these companies can more easily generate, analyze, aggregate, integrate and exchange health and wellness data. Analyzing and integrating these HIPAA-exempt data are key aspects of many of these companies’ business models and their databases are sometimes considered to be a significant part of their value. As with FDA regulations, HIPAA compliance can be expensive to establish and maintain, and requires specific expertise on the part of the entrepreneurs and investors involved. When these technologies are HIPAA exempt, it requires less initial capital to develop the product and bring it to market.
Chapter 1 (Introduction) Notes

1 According to Apple, Inc., the first iPhone was equipped with an accelerometer to assess whether or not the phone was in portrait (vertical) or landscape (horizontal) mode so that the phone could automatically adjust the screen image accordingly. Ambient light sensors allowed the device to adjust screen brightness automatically based on the amount of light in the environment, and proximity sensors allowed the device to sense when a user has placed the phone near their face to prevent inadvertent dialing/touchscreen contact during phone calls.

2 That is, by Apple itself. Third party apps may have provided users with access to a version of this data.

3 Apple’s mobile operating system.

4 Some of these devices are sold both directly to consumers and to employers for employee wellness programs as well as insurers for their policyholders.

5 As of March 2015, according to Fitbit’s S-1 filing with the Securities and Exchange Commission.

6 As of October 20, 2015.

7 In 2015, Google founders Larry Page and Sergey Brin created a new parent company, Alphabet, Inc. and have housed Google, Inc. within this parent company, along with several other of their companies. However, for the purposes of this dissertation, I will refer to the larger company and its products as “Google,” rather than “Alphabet” because many of the technologies I describe were developed under Google.

8 According to a Research2Guidance Report (2016:7), there are 105,000 health apps in the Google Play store for Android devices and 126,000 health apps in the Apple App Store. Most developers develop their apps for both platforms so there is likely a significant amount of overlap.

9 Equity financing is covered in depth in Chapter 2. Equity investors provide capital to companies in exchange for equity, or ownership, in the company.

10 However, Larkin 2013 contends that in some cases, such as in colonial projects, infrastructure is prominently and spectacularly displayed to draw subjects in and demonstrate modernity for political effect. He thus argues that scholars of infrastructure should ask “how (in)visibility is mobilized and why” rather than rely on a premise that infrastructure is always invisible (Larkin 2013:336).

11 Tonkiss (2015) notes that while not having easy access to [reliable, functioning] infrastructures is the result of and often exacerbates existing inequity, sometimes being too close to infrastructure has similar effects, such as living proximal to highways.

12 According to Foster (2007), financial capitalism arose out of monopoly capitalism, which produced increasing profits and fewer investment opportunities, resulting in a slowdown in capital accumulation. Financial institutions created new financial instruments to manage these immense surpluses. Christopherson, Martin and Pollard (2013:354) contend that financialization has also been spurred by neoliberal processes and reforms, such as “a decimation of trade unions and of the values underlying collective bargaining, a gradual undermining of the role of
government through deregulation and a redefinition of the citizen as a consumer of a bundle of services rather than a member of society with collective obligations and rights.” Unlike others, Foster (2007) argues that because financial capital stems from surpluses from large monopolies, monopoly capitalism has not been entirely supplanted by financial capitalism and instead argues that contemporary capitalism is a hybrid of monopoly-finance capitalism.

13 Web 2.0 technologies describe sites that encourage users to generate content themselves and thereby participate in the maintenance and content of the site. Examples include social media sites like Facebook, video sharing sites like YouTube, and Wikipedia.

14 Angel Launch Investor Forum is a brand that hosts a variety of startup pitch events and investor panel events in the Bay Area and Los Angeles. [http://www.angellaunch.com/](http://www.angellaunch.com/)

15 Co-working facilities, which are increasingly common in the Bay Area are office environments that are available to freelancers, startups, independent contractors, and others typically on a subscription basis. These facilities provide startups with access to office space without having to commit to a lease.

16 Because these are publicly traded companies, investors can be all over the world. Thus, the company typically advertises the earnings call event in advance on investor relations portion of their website and provides an 800 number for investors to listen in. Transcripts of these calls are sometimes made available through the company or through NASDAQ.

17 In one instance, a founder I reached out to who I was not aware was already in partnership with UCSF, assumed that I had contacted him in regards to this partnership. He therefore connected me with his Director for Strategic Alliances, as UCSF was considered a strategic alliance for the company. After interviewing this director, he connected me with the other co-founder of this company, whom I also interviewed.

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**Chapter 2 Notes**

18 As I describe in the introduction and in Chapter 3, Apple’s iPhone operating system, iOS, includes a health application since 2014 that cannot be disabled or deleted. As I describe in this chapter and in Chapter 3, most smartphones are equipped with accelerometers and other motion sensors that cannot be disabled and track activity and movement.

19 This resource is maintained by the American Society of Civil of Engineers, the American Institute of Mining, Metallurgical, and Petroleum Engineers, the American Institute of Chemical Engineers, the American Society of Mechanical Engineers, the Society of Women Engineers, and the Institute of Electrical and Electronics Engineers (IEEE)

20 Spread spectrum communications were originally developed as military technologies to infiltrate enemy radio communications without being noticed.

21 The name Wi-Fi was meant to be a pun on hi-fi (high fidelity) and is sometimes said to stand for Wireless Fidelity

22 As with other wireless standards, an alliance of several companies was formed to develop Bluetooth technology. One alliance participant coined the name “Bluetooth” after a 10th-century Danish king, supposedly known to have a rotted tooth that appeared blue. This king, Harlad Gormsson, was thus known as Harlad Bluetooth (Blåtand in Danish), and was famed for uniting Denmark. The Bluetooth alliance, which sought to unify several companies around a Bluetooth
standard to promote interoperability, thus named its standard after this unifying Danish king. The Bluetooth symbol is a combination of Harlad Bluetooth’s initials in Scandinavian Runes.

23 Formally known as Navigation System for Timing and Ranging (NAVSTAR)
24 According to Cunha and LoPiccalo (2014), the United States military first used radio frequencies to determine location when tracking the Soviet satellite, Sputnik, after its launch in 1957. This formed the basis for the development of the Navy’s TRANSIT Navigation System to more accurately track the position of submarines using satellites in order to fire missiles more precisely. This system later developed into the NAVSTAR system.
25 According to Cunha and LoPiccalo (2014), President Reagan authorized the FAA to develop a civilian version of GPS as a result of a flight out of Anchorage, Alaska that that was shot down over Soviet airspace in 1983. Because GPS was not available to the aviation industry, they could not have tracked the position of the flight. After this event, President Reagan authorized the development of a civilian GPS in part to prevent this kind of event.
26 Analog cellular networks work by translating audio or video signal into electronic pulses. Digital cellular networks instead translate those signals into binary information (0s and 1s) to compress the data, which is then reassembled to the receiving device. This compression process allows much more data to travel in the space of a single analog call.
27 This is known as a graphical user interface
28 Rather than having a reduced version of the web, which was common on other smartphones at the time, the first iPhone was the first smartphone to replicate a desktop web browsing experience on the phone.
29 And indeed may be eliding these distinctions.
30 Google, Inc., acquired Android, an open source handset operating system, for $50M in 2007. Android was started by Andy Rubin, who had designed other popular devices for T-Mobile, such as the Sidekick smartphone, and he included several features that he and his colleagues innovated for that previous device when building Android.
31 There were several mobile operating system companies operating in the late 1990s and early 2000s, including Symbian, which ran on many Nokia, Motorola, and Ericsson devices, and Windows CE, owned and developed by Microsoft, Inc. The BlackBerry ran on its own operating system (BlackBerry OS).
32 The BlackBerry also had a notification system, which it developed prior to the release of the G1.
33 Between 2008-2016, Google, Inc. partnered with other phone manufacturers to create its devices but in 2016, the company released its first smartphone, which it claims to have manufactured and developed itself (the URL to access the phone even indicates as much http://madeby.google.com and the company widely promoted the hashtag #madebygoogle during its launch). However, according to Su of Forbes, the device is manufactured by HTC (Su 2016).
34 According to ComScore, a measurement and analytics company, in January 2016 52.8% of US smartphone subscribers use a device running Android and 43.6% of US smartphone subscribers use a device that runs iOS. https://www.comscore.com/Insights/Rankings/comScore-Reports-January-2016-US-Smartphone-Subscriber-Market-Share Accessed 10/8/16
35 Apple, Inc., is the most valuable company in the US by market capitalization at 614.6B (10/8/16) and followed by Google, Inc. at 540.4B.
36 Google actually acquired Motorola’s consumer mobile arm (Motorola Mobility) in 2011. However, in 2014, Google sold Motorola Mobility to Chinese technology company Lenovo, though it retained several thousand patents.

37 Many contemporary smartphones have more than one microphone that can be used for different activities (e.g., phone calls, audio recording, and voice command technologies like Siri).

38 Additionally, these sensors have been integrated into third-party applications such that a user can use their fingerprints to make purchases, view their bank account, and many other activities.

39 The first iPhone had a proximity sensor to sense the distance between the phone and the user’s face. This was necessary in part because of the touchscreen, which needed to automatically turn off when a user made a call so that their face impressions on the phone were not sensed by the screen. Thus, having a touchscreen required this kind of sensor.

40 Near Field Communication allows two devices to communicate with each other when in very close range of each other (up to 5 cm apart) using radio frequency.

41 These services, such as Apple Pay and Google Wallet, allow users to link their credit cards and bank accounts to their devices and use their smartphones in lieu of a credit or debit card.


43 While there are multiple types of securities and the term can refer to a variety of intangible investments or a tradable financial asset, in this case I am referring to equity securities, or common stock.

44 Sometimes investors advance capital in exchange for convertible debt, rather than in the form of equity. In these cases, to avoid setting an equity valuation a company and their investor(s) may instead choose to secure a convertible note, which functions like a loan that converts to equity for the investor but can be paid back by the company prior to the point of conversion.

45 Preferred stock is a class of ownership in a company that allows investors to “get a 6% to 8% interest and a liquidation preference of one times their money back before the common shareholders begin to participate in any sale proceeds for the business” (Deeb 2014). In general, preferred stock pays higher dividends than common stock. Sometimes investors opt for convertible preferred stock, which allows them to convert their preferred shares into a specific number of common shares after a certain date. This is strategy for protecting their investment if the company does not perform well once publicly traded.

46 Typically more than one year before a return on the investment is realized.

47 According to the SEC, an accredited investor must have an “earned income that exceeds $200,000” individually or “$300,000 together with a spouse” for three years or “have a net worth [of] over $1 million, either alone or together with a spouse” (SEC Office of Investor Education and Advocacy 2013). According to the SEC, investors must be accredited to trade a company’s securities for capital because it indicates that the investor is solvent enough to “bear the economic risk of investing in these unregistered securities” (https://www.investor.gov/news-alerts/investor-bulletins/investor-bulletin-accredited-investors).

48 As part of Title III of the JOBS Act, the SEC now allows unaccredited investors to exchange personal capital for equity in an early stage company, known as equity crowdfunding.
Individuals worth less than $100,000 are permitted to invest 5% of their income/net worth or up to $2000 over a year in exchange for equity. Those who are worth more are permitted to invest up to 10% of their income/net worth. Unaccredited investors may not acquire more than $100,000 worth of equity over a 12-month period. According to the SEC, “the recommended rules would...enable individuals to purchase securities in crowdfunding offerings subject to certain limits, require companies to disclose certain information about their business and securities offering, and create a regulatory framework for the intermediaries facilitating crowdfunding transactions.” (2015)

49 AngelList is a web-based platform that mediates connections between angel investors, startups seeking angel funds, and those seeking employment in the startup sector and provides startups with the opportunity to raise money from angel investors directly on the site.

50 This capital comes from “surplus liquidity” of the parent company, meaning that the cash flow into the company exceeds money spent (Lantz, Sahut, and Teulon 2011:370).

51 This is in part because the federal government encouraged closed-end funds through the Small Business Investment Companies (SBIC) program, which made risk capital pools available to investment firms in order to spur the venture capital industry to encourage American technological innovation during the Cold War era (Gompers and Lerner 2001). During this time, individual investors comprised the largest source of funds for venture capital firms.

52 These reforms allowed 60 percent (previously 50 percent) of the excess net of these gains to be tax deductible (Briner 1979).

53 Long-term capital gains “result from sales or exchanges of capital assets held one year or longer” (Briner 1979:533).

54 Typically carried interest profit is 20-25% of a fund’s annual profit but in some cases is only created if the profit exceeds a pre-determined benchmark known as a hurdle rate (Metrick and Yasuda 2010).

55 When and if the startup holds an initial public offering

56 According to Fitza, Matusik, and Mosakowski (2009:390), professionalization denotes “bringing in professional managers, standardizing HR policies, hiring marketing executives, adopting stock option plans.”

57 In some cases, a VC may approach another investor or firm to invest in a round together (known as syndication)—potentially because of area expertise or to spread the risk of the investment.

58 Incubators and accelerators are programs that startups can apply to participate in typically during their seed stage (see Figure 2.2). These programs provide startups with some capital and usually several infrastructural resources, such as office space and a mailing address, in addition to networks and contacts for future funding. Participating in these kinds of programs can demonstrate viability and credibility to other investors and provides a jump start for new companies.

59 According to Gompers and colleagues (2016), VC firms may be approached by or consider financing at least 400 companies a year and typically only invest in 4 to 5 ventures a year. These strategies help the firm parse the candidates they are considering.

60 Because deal structuring takes time, the negotiation of these terms is sometimes initiated prior to the due diligence phase.

61 While angel investors vet the companies they consider investing in, they often do not have the resources to engage in full-fledged due diligence.
Some due diligence activities, particularly legal due diligence, may also reveal issues that would be an automatic loss for the firm, such as the startup is using unlicensed code or infringing on another company’s IP. While failure due to market uncertainty is acceptable and celebrated, failure due to predictable errors may not be (Personal Communication 2016).


Chapter 3 Notes

Available at: https://www.fitbit.com/whyfitbit Accessed February 19, 2016
Fitbit has since lost some of its value and its market capitalization has hovered between $2-4B due to lower than expected earnings.
The S-1 filing, known as the “Registration Statement Under the Securities Exchange Act of 1933”, is a type of registration required by the SEC for companies that would like to be listed on a national exchange (to become a publicly traded company). The form requires companies to describe their offering price, proceeds, business model, competition, and other information.
While having an open API is becoming the standard for viable health and wellness technology companies, the extent of this openness and how this openness works is not standard. Some companies allow users to download some or all of their own, personal data from the company for their (user’s) own analytics. Some companies allow other companies to explore portions of their data but limit what is shared and prevent other companies from storing their data for future analytics.
Lumosity is a “Cognitive Training” company that develops games and quizzes for consumers to test their mental acuity
Context awareness refers to the ability of a device to sense location and provide content to a user based on that context, nearby objects, and user characteristics (Islam and Want 2014).

Chapter 4 Notes

(Hall 1986)
This is because Althusser argues that ideology is eternal throughout classed history, there is no outside of ideology.
For Foucault, normalizing judgment is a mechanism through which disciplinary power is effected, wherein measurements, observations, and surveillance of subjects leads to the production of standards of behavior and bodies that serves to differentiate (divide) individuals and their potentials that allows for the distribution of individuals based on capacity. Foucault (Foucault 1991:183) argues that this kind of discipline "compares, differentiates, hierarchies, homogenizes, excludes. In short, it normalizes."
Behavioral economists often refer to their research as experiments in human behavior.
While Ariely (2010) refers to these behaviors as irrational, others, such as Thaler and Sunstein (2009) and Mullainathan and Thaler (2000), make very similar arguments but draw on Herbert Simon’s original language of “bounded rationality” rather than employing the term “irrationality.”


Some of these technologies collect data, such as steps and heart rate, that a consumer could count themselves. However, many of these same devices also claim to collect and integrate data on sleep movement, breathing capacity, sweat composition, and skin temperature that would be considerably more difficult for consumers to continuously capture on their own.

Here, Lyra is referring to the average daily step goal that Fitbit encourages users to achieve.

A similar set of integrations may be already underway, as Ford Motor Company is currently working on allowing wearable devices to connect to users’ vehicles, such that the car would be able to detect low glucose levels before the human themselves could: https://media.ford.com/content/fordmedia-mobile/fna/us/en/news/2016/01/11/new-ford-lab-integrates-wearables-and-vehicles.html

Rakesh is referring to the Nest® home automation system produced by Nest® Labs, now owned by Google. The Nest® devices are considered IoT, programmable technologies that use sensors and machine learning to regulate home temperature, monitor home security, and detect smoke inside the home.

Because this home automation device is manufactured by Google, access to many users’ personal calendars is fairly seamless because Google’s calendar service is already very popular among U.S. consumers.

Many popular wearables integrate in this way with NEST ® products, including Misfit wearables, which even has a separate mobile app called Misfit Home. https://misfit.com/products/misfit-home-app

Misfit Wearables was recently acquired by Fossil Group, Inc., a fashion and accessories company.

These advertisements are for mobile applications that serve as companions to the Misfit Wearables activity trackers. These advertisements can be accessed at: https://misfit.com/apps. Accessed: 11/9/16

A selfie is a type of photograph that one typically takes of oneself using the front-facing camera of a device.

In many cases, if a consumer loses a wearable device, they do not lose access to the data they have accumulated from the device because those data are often cloud-based and available via the companion mobile and web applications.

Location-based service that allows you to locate people you are connected to on social media platforms.

Chapter 5 (Conclusion) Notes

The top five most valuable companies in the U.S. by market capitalization are: Apple, Inc. ($633.9B), Google, Inc. ($566.7B), Microsoft Corporation ($474.8B) Amazon.com, Inc. ($397.3B), and Facebook, Inc. ($382.7B), as of 10/24/16.
Appendices Notes

90 The FDA defines “low risk” as follows: “Whether a device is low risk for purposes of this guidance is determined by whether or not the product: 1) is invasive; 2) involves an intervention or technology that may pose a risk to a user’s safety if device controls are not applied, such as risks from lasers, radiation exposure, or implants; 3) raises novel questions of usability; or 4) raises questions of biocompatibility.” (U.S. Food and Drug Administration 2015)

91 The FDA defines a medical device as follows: "an instrument, apparatus, implement, machine, contrivance, implant, in vitro reagent, or other similar or related article, including a component part, or accessory which is: recognized in the official National Formulary, or the United States Pharmacopoeia, or any supplement to them; intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease, in man or other animals; intended to affect the structure or any function of the body of man or other animals, and which does not achieve its primary intended purposes through chemical action within or on the body of man or other animals and which is not dependent upon being metabolized for the achievement of any of its primary intended purposes.” (http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/Overview/ClassifyYourDevice/ucm051512.htm)

92 Some of the startup companies involved in this study were selling (or planning to sell) their products directly to consumers and trying to partner with providers to encourage patients to buy their products. Some other companies developed mobile and web-based apps that connected health providers with patients and marketed their products to both parties.
REFERENCES


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