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Disruptive Innovation and the Idea of Technology

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ABSTRACT

From its obscure origins in management theory, disruptive innovation has become one of the concepts used to describe how networked digital technologies and platforms transform industries and institutions. In this paper, I will examine how contested, and at times incommensurable, iterations of disruptive innovation share a similar idea of *technology*. Drawing upon discourses of disruptive innovation from management theory, institutional policies, and popular culture reveals a shared idea of technology whose characteristics include a reified idea of *technology* and a horizon of expectations in which fear of falling behind influences ideas about technological change.

Keywords: Disruptive Innovation; Technology; Conceptual History; Fear; Reification.

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INTRODUCTION

Disruptive innovation has captured the contemporary technological imagination. The term, or more precisely the theory of disruptive innovation, was developed in the mid-1990s by business professor Clayton M. Christensen to explain why successful, competitive, and well-managed firms fail when confronted with technological change (Bower & Christensen, 1995; Christensen, 1997; Christensen & Rosenbloom, 1995). In the time that has passed since then, disruptive innovation has moved beyond its business school origins and is now widely applied across a variety of initiatives. It is championed as a solution for the problems that plague educational institutions (Eryring & Christensen, 2011; Sims, 2017), health care (Hwang & Christensen, 2008; Sharon, 2016), and legal systems (Pistone & Horn, 2016). It is a useful policy tool for proponents of deregulation and market expansion (Christensen, Craig & Hart, 2001), it is used to promote circular economies and transitions to cleaner energy (Tyfield, 2018), and critical social theorists use it to advance the project of a new post-capitalist political economy (Mason, 2015).

Popularity and inclusivity, though, has its critics. Foremost amongst these are business professors and management theorists, who, like all academics, become exasperated when terms and concepts from their specialized fields are used incorrectly. Joshua Gans (2016) describes "the angst" he feels at the misapplication of disruptive innovation: "…use of the term has gotten out of control. Everything and everyone can supposedly be disruptive. Moreover, everyone is supposed to become disruptive…none of these notions are obvious or obviously true" (vii). Christensen similarly bemoans the sloppy inclusivity of his theory: "disruption theory is in danger of becoming a victim of its own success…the theory's core concepts have been widely misunderstood and its basic tenets frequently misapplied…too many people who speak of "disruption" have not read a serious book or article on the subject" (Christensen, Raynor & McDonald, 2015, p. 46). Reading these complaints, the message is clear: disruptive innovation should be studied and applied carefully so as to not contradict its formal theorization. Unintentionally, these

complaints convey another message: what began as a somewhat obscure management theory has moved beyond its business school origins and is now one of the concepts used to describe processes by which networked digital technologies and platforms are endowed with the capability to transform what are seen as anachronistic and inefficient industries and institutions. As a concept, disruptive innovation is intertwined with technology; but, as I suggest in the following, technology in this case does not refer any particular artifact, but rather an idea of technology. As the semantic field of disruptive innovation grows, it has become a framework through which to conceptualize technology. Following the philosopher of technology Andrew Feenberg (2017) who asks "what we do when we envisage the world with a technical intention" (p. 137), I contend that disruptive innovation is a way to envisage the world with a specific technical intention that is distinct from other conceptual engagements with technology, such as sustainability, conservation, or responsibility. If Gans and Christensen are correct in recognizing an almost ubiquitous "disruptive imperative," then the expansion of the term's semantic field, and in particular the idea, or concept, of technology found within it, is as important as debates concerning theoretical fidelity or methodological consistency.

The concept technology, as historians and philosophers have demonstrated, refers to both material artifacts and, borrowing a term from Hans Robert Jauss (1982), a horizon of expectations through which these artifacts are endowed with meaning (Herf, 1984; Kline, 1995; Long, 1991; Marx, 1997; Oldenziel, 1999; Schatzberg, 2006; Schatzberg, 2012). Examples of this include the idea that technologies are essential "male," (Oldenziel, 1999; van Oost, 2003; Schatzberg, 2012) or that technology in and of itself is an indication of progress (Marx, 1997; Oldenziel, 1999). Disruptive innovation, in this sense, performs a hermeneutic function in relation to technology; it is a background of assumptions and attitudes through which technology is thematized and made meaningful, providing a context that directs technological society towards particular ends while simultaneously foregoing other ends. This is similar to the hermeneutic function that intellectual property

performs. As Pamela Long (1991) writes, the development of intellectual property endowed the practice of material invention with particular meanings, including proprietary attitudes towards craft knowledge, the notion that invention is a product of individual ingenuity and genius, and an a priori assumption concerning the commercial value of new technical goods. In this way, the idea of intellectual property directs attitudes and expectations about technology towards particular ends (possessive individualism and the financial incentivization of invention) while foregoing other ends (communal ownership of craft knowledge and invention). It is not insignificant, then, to claim that automation is disrupting the labour market or that Google's foray into health care is disruptive or that Uber is disrupting the taxi industry because in these and many other instances, different sets of shared understandings and expectations regarding technology are drawn upon to explain complex processes through one handy and self-explanatory concept: disruptive innovation.

The following paper attempts to draw out characteristics of this particular concept of technology by first examining in more detail the history and formal theorization of disruptive innovation and explaining its expansion from management theory to popular culture. Moving away from debates about theoretical consistency, I will draw out two characteristics of technology that can be found across both the formal theorization and the popularization of disruptive innovation. First, I point to a characteristic that is co-original with the concept of technology itself – reification. Reification is a complex idea that is realized in a variety of ideas about technology, including attitudes about the inevitability and autonomous trajectory of proposed disruptive technological and the practice of understanding technology by reducing it to function. The reification of technology, though, is not restricted to disruptive innovation. What is unique to disruptive innovation, though, is an idea of technology that is intertwined with fear, and in particular, the fear of falling behind amidst accelerating technological change. To draw out this notion of fear in more detail, I turn to different examples, including ride sharing platforms,

the French-German Joint European Disruptive Initiative, and Clayton Christensen's empirical work on the disk drive industry. Across these different articulations of disruptive innovation, I argue, is a sociotechnical horizon of expectations in which the fear of falling behind as a response to a rapidly changing technological environment contributes to a hermeneutic framework through which technology, and our engagements with it, are made meaningful. I conclude by suggesting that disruptive technology need not be our fate and that recognizing contingent ideas of technology can open up discursive moments of contestation.

DISRUPTIVE INNOVATION: FROM OBSCURITY TO UBIQUITY

The term, or more precisely the theory of disruptive innovation, was developed in the mid-1990s by business professor Clayton M. Christensen (Bower & Christensen, 1995; Christensen, 1997; Christensen & Rosenbloom, 1995). It originated out of case studies that were used to explore why successful, competitive, and well-managed firms failed when confronted with technological change. Successful incumbent firms, Christensen argued, tended to focus on their most profitable customers and so developed "sustaining" technologies that improved products for existing customers: more comfortable seats in trains or on airplanes, increased horsepower in car engines, washing machines with more cleaning features, or phones that take better photos. Sustaining technologies, Christensen writes, can be characterized by a trajectory of technological development that is plotted along a rate of improvement measured against the functional attributes of existing products, enabling a predictable trajectory of improvement towards which innovations should aim (Bower & Christensen, 1995; Christensen, 1997; Christensen, Craig

& Hart, 2001).[1] By prioritizing existing attributes, sustaining technologies tend to overshoot the needs of their consumers. An automobile that can exceed 300km/h, for example, unnecessarily exceeds what is needed.

In theory, developing sustaining innovations is what good firms are supposed to do to increase profits and stimulate growth: listen to customers and improve existing products to better serve those customers. Yet, as incumbent firms focus on improving their products and services for their most demanding and most profitable customers, they failed to meet the needs of other non-consumers: people who don't drive or travel on airplanes or who don't own washing machines or smartphones. This is where disruptive technologies, or disruptive innovations, enter. Entrants that prove disruptive begin by successfully targeting overlooked non-consumers and delivering similar functionality that incumbents do with technologies that tend to be cheaper, smaller, less durable, and more convenient. Incumbent firms, chasing higher profitability, tend not to respond to these entrants. Entrants then move upmarket, delivering the performance that incumbents' mainstream customers require, while preserving the advantages that drove their early success, like lower prices or greater convenience. When mainstream customers start adopting the new products of new entrants in volume, disruption has occurred.

An example of disruptive innovation comes from the photocopier industry. In the early days of photocopying machines, Xerox dominated the market by charging high prices for cumbersome machines that were purchased by large businesses and corporations. The trajectory of technological change was directed towards sustaining innovations that catered to the needs of these customers, such as increasing the number of pages copied per minute. The consequence of this was that individuals and groups such as small businesses and community organizations were priced out of the market and so were

[1] Christensen's ideas on technological trajectories are taken from Giovanni Dosi's (1982) work on technological paradigms, see Christensen & Rosenbloom (1995).

forced to use mimeograph machines or carbon paper. In the late 1970s, new firms introduced personal photocopiers that were smaller, cheaper, less reliable, and more convenient, which led to a new market. Although these machines were technically inferior to Xerox's machines, as the market grew, personal photocopiers became increasingly better and began to challenge, or disrupt, Xerox's dominance of the photocopy machine market (Christensen, Raynor & McDonald, 2015, p. 47).

The case of Netflix and Blockbuster is perhaps more relevant for contemporary articulations of disruptive innovation that refer to digital networked digital technologies and platforms. Netflix began in 1997 on the wave of a new technical format, DVDs, which were smaller and lighter than VHS tapes. This enabled Netflix to use a combination of online tools and postal delivery instead of a bricks and mortar retail outlet. At this time, Netflix was a niche service that appealed to non-users of Blockbuster, largely those who did not have access to retail outlets or cinephiles who were not satisfied with Blockbuster's emphasis on new releases of mainstream popular films. In the early 2000s Netflix changed their business model to a subscription-based service that allowed consumers to pay a flat monthly rate allowing them access to all of the films they wanted without late fees. Blockbuster did not consider the customers who were drawn to Netflix and instead focused on sustaining innovations for their existing, and most profitable, customers who wanted new releases and other impulse purchases. Sustaining innovations, in this case, were an increase in the quantity of new releases and even guaranteeing their availability. Disruption occurred when Netflix shifted to an online streaming service built on its subscription model. Very quickly, Netflix captured a market that was once dominated by Blockbuster (Christensen, Raynor & McDonald, 2015, p. 48-49; Gans, 2016, p. 13-22).

These descriptions, although useful for understanding the theory of disruptive innovation, fail to explain how a management theory become a catch-all term that seems uniquely suited to describe the shift towards using big data, personalization, and

analytics to transform existing ways of producing, distributing, and consuming goods and services. The shift from management theory to popular culture occurred due to two interrelated changes. First, the theory became analytically refined in its description of disruption by distinguishing between disruptive innovations that enter markets through low-end footholds (providing a 'good-enough' product to customers who cannot afford the products of the incumbent firm nor do they require the performance of these products) and new-market footholds (creating a market where one did not exist before, finding a way to turn non-consumers into consumer) (Christensen & Raynor, 2003). This distinction widened the scope of the theory's potential application. Second, and more significantly, disruptive innovation changed its orientation from something to be defended against into a strategy that could be used for economic, political, or philanthropic success (Christensen, 2006). In its original form, the theory developed out of case studies that explained why successful and well-managed companies fail when confronted with technological change. In this sense, Christensen situated his theory within the context of protecting successful companies against disruptive technologies while also pointing out how these same firms could leverage disruptive technologies for their own success (Bower & Christensen, 1995, p. 1-53). At the beginning of the twenty-first century, Christensen realized that a focus on disruptive technologies led to anomalies in his observations and he recognized that success or failure was not "a technological problem; it was a business model problem" (Christensen, 2006, p.43). As a business model, disruptive innovation allowed the theory's proponents to turn their attention away from defending firms against disruptive innovation towards strategizing how to succeed through disruptive innovation. As a management strategy and a business model with an increased scope of application, disruptive innovation became much easier to apply.

Given the ease with which artifacts and processes are termed disruptive, wariness and critique can be expected. In its more simplistic iterations, disruptive innovation is written

about with an aura of inevitability wherein every industry or institution – from education to health care to culture – will become disrupted through networked digital technologies.[2] Wide spread popularization has resulted in increased empirical scrutiny of its accuracy and robustness which has led to questions about the methodological foundations of Christensen's inductive reasoning. Historian Jill Lepore (2014) critiqued Christensen's method of "handpicked case studies" as a "notoriously weak foundation on which to build a theory," and after reviewing his case studies found that his sources "are often dubious and his logic questionable." Researchers in management theory have also found Christensen's reasoning questionable, noting that of the 77 cases used by Christensen and Raynor (2003) to demonstrate disruptive innovation, only 7 cases (9%) contained all of the elements of disruptive innovation (King & Baartartogtokh, 2015; see also Kitroeff, 2015).

Disruptive innovation can also be dismissed as empty rhetoric used to dress up old-fashioned ideas about the triumph of technological progress for contemporary neoliberal ambitions. From this perspective, the term disruptive innovation may be new, as are the sociotechnical processes and changes that are typically associated with it, but the attitudes, assumptions, and ambitions that correspond with disruptive innovation are not bound to its contemporary usage. In *The Communist Manifesto*, Karl Marx and Friedrich Engels (1994 [1848]) describe the nineteenth-century capitalist labour process in terms that today's disruptive innovators could easily claim as their own: "Constant revolutionizing of production, uninterrupted disturbance of all social conditions, everlasting uncertainty and agitation distinguish the bourgeois epoch from all earlier ones" (p.161; see also Berman 1982). Other variations of disruptive innovation include Joseph Schumpeter's (2010 [1943]) idea of creative destruction, which foreshadowed the same microlevel disruptive processes "discovered" by Clayton Christensen in the 1990s

[2] This is evident in book titles like The Laws of Disruption: Harnessing the new Forces that Govern Life and Business in the Digital Age (2009).

at the macrolevel. Beyond political economy, hints of disruptive innovation can be found in the ideas of the Italian Futurists, who sought to integrate the logic of machinery into all traditional art forms, which were stale, decadent, and in need of replacement.[3]

Given these critiques, it would be easy to dismiss disruptive innovation as the latest in a list of promotional buzzwords such as "game-changer," "cutting edge," "next generation," and "out-of-the-box." Yet, empirical shortcomings and ease of applicability should not be mistaken as evidence of the term's superficiality. The significance of disruptive innovation is its alignment with a particular concept, or idea, of *technology*. The widespread applicability of disruptive innovation to describe a number of artifacts and technically mediated processes, in this regard, is useful because it allows one to cast a wide net to better draw out the demarcations and boundaries that are contributing to a redefinition of *technology*. In what follows I explain in more detail the work of historians and philosophers who have traced the semantic and artifactual bounding processes that correspond with the idea of *technology*. Following this, I examine in more detail what it means to consider *technology* through the concept of disruptive innovation.

THE IDEA OF TECHNOLOGY

The English word *technology* absorbs what in many other languages is a combination of two words: technique and technology. As Michel Serres (2015) points out for his English readers, "The French language distinguishes between *techniques* and *technologies*. Very generally, a technique is the practice of fabrication, whereas technology (from the Greek *tekhnė*, technique, and *logos*, discourse or study) is a discourse about techniques" (p. 44; see also Schatzberg, 2006, p. 489). True to its etymological and semantic heritage,

[3] Just as the more enthusiastic proponents of disruptive innovation celebrate the increasing speed of digital networks and come to view the past as a hindrance to their version of progress, the Futurists wanted to "destroy the cult of the past, the obsession with the ancients… (Boccioni et. al. 1910 [1973], p. 26)," and announced that they "will destroy the museums, libraries, academies of every kind (Marinetti, 1909 [1973], p. 22)." As Marshall Berman (1982) writes, "There are no ambiguities here: tradition – all the world's traditions thrown together – simply equals docile slavery, and modernity equals freedom; there are no loose ends" (p. 24).

technology first appeared in English in the seventeenth century in reference to "a kind of learning, discourse, or treatise, concerned with the mechanical arts" (Marx, 1997, p. 966). Until the end of the nineteenth century, the objects of study that today would be referred to as technology went by terms such as machinery, art, applied science, applied arts, useful arts, and craft. By the early twentieth century, *technology* had supplanted these terms:

> …before 1930, issues that historians now discuss in terms of technology were framed in such terms as useful arts, manufacturing, industry, invention, applied science, and the machine. In other words, when historians now address 'attitudes towards technology' before 1930, they are employing an analyst's category not used by the historical actors themselves (Schatzberg, 2006, p. 486).

The introduction of *technology* to account for these objects and practices was not an innocent endeavor. This was a semantic and artifactual bounding process. *Technology* cemented the exclusion of artistic and craft knowledge from industrial modernity (Schatzberg, 2012) and contributed to a gendered ontology of what counts as *technology* and what does not. As Ruth Oldenziel (1999) argues, *technology* became the exclusive purview of (white) men as quilts, corsets and other objects traditionally associated with women were relegated to the status of "craft," thus removing these objects and activities from the privileged realm of modern technology. Omitting the objects produced by artists and craftspeople from the scope of *technology* corresponded with the privileging of professional engineers as the sole producers of technology, effectively fixing its artifactual dimension to large machines and sociotechnical systems like dams, railways, and other technological projects that were the purview of engineers (Marx, 1997; Oldenziel, 1999; Schatzberg, 2002). Railways, dams, and airplanes, which were demonstrated as technological marvels in the early twentieth century, no longer seem to register as *technology*. In the early twenty-first century, the case of disruptive innovation can be used to examine how contemporary semantic and artifactual distinctions are being constructed and performed.

Artifactually, disruptive technology, or more colloquially tech, refers to digital networked technologies that use increasing processing speeds, big data, personalization, and analytics to transform existing ways of producing, distributing, and consuming goods and services. Digital platforms like Uber, which are often pointed to as disruptive innovations, are impossible without smartphones, digital networks, and a myriad of algorithms that rank, rate, personalize, and track the experience. A European Research Council (ERC) call for research funding titled "Transformative Impact of Disruptive Technologies in Public Services" is also telling in this regard. Independent of any formal theory of disruptive innovation, the ERC points to objects and processes such as block-chain, Internet of Things, AI, and big data analytics that, by virtue of their disruptive potential, are defined as technology.[4]

Artifacts and the processes that they mediate, though, do not constitute the extent of *technology:*

> Although in common parlance nowadays this material aspect is what the concept of *technology* tacitly refers to, such a limited meaning… is ambiguous and misleading… the artifactual component only constitutes a part of the whole system (Marx, 1997, p. 979).

For Marx, *technology* is not simply a collection of artifacts, but also the contexts through which those objects defined as *technology* are made meaningful. And, just as the artifactual scope of *technology* is contingent, so too is the hermeneutic dimension. *Technology* has included ideas about progress, standards and measures of civilizational and cultural superiority, and more recently, more sober expectations of the social benefits (and costs) of technology (Marx, 1994; Oldenziel, 1999). In what follows, I begin to trace the hermeneutic dimensions of disruptive *technology* by looking at how

[4] Available at: http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/dt-transformations-02-2018-2019-2020.html (Accessed 16 June 2019).

reification and fear shape the horizon of expectations through which technical intentions are realized.

REIFIED *TECHNOLOGY* IN THE ERA OF DISRUPTION

From its origins in Marxist theory, reification in relation to technology refers to the objectification of capitalism in the design of so-called neutral technologies (Feenberg, 2002; Lukacs, 1973 [1925]).[5] Marx, for example, demonstrated this through reference to cases in which the interests of capital to increase surplus-value influenced the trajectory and design of "neutral" or "objective" machines. In response to the legal restrictions on the length of the working day, for example, capital seeks to compensate itself, "by a systematic heightening of the intensity of labour, and to convert every improvement in machinery into a more perfect means of exhausting the workman" (Marx, 1954 [1887]), p. 393).

A recent critique of disruptive innovation points to a similar process of reification in which an activity (hailing a taxi) is decontextualized from a complex network of people, organizations, knowledge, and history and reduced to a technical function:

> What tech enthusiasts call "disruption" is in fact almost always directed at forms of organization that preserve a modicum of workers' control over knowledge and the products of labor. Because London taxicabs are controlled by people who have built up impressive maps of one of the world's most complex cities in their brains, they ought to be replaced by self-driving cars operating on Google maps…automation isn't a neutral, inevitable part of capitalism. It comes about through the desire to break formal and informal systems of workers' control – including unions – and replace them with managerially controlled and minutely surveilled systems of piecework (*After Capitalism*, p. 10).

[5] The philosopher Herbert Marcuse (1964) wrote that modern technology, "has become the great vehicle of reification – reification in its most mature and effective form. The social position of the individual and his relation to others appear not only to be determined by objective qualities and laws, but these qualities and laws seem to lose their mysterious and uncontrollable character; they appear as calculable manifestations of (scientific) rationality" (p. 168-169). Philosopher of technology Andrew Feenberg (2014) complements these insights about reification: "Existing science and technology cannot transcend the capitalist world. Rather, they are destined to reproduce it by their very structure. They are inherently conservative, not because they are ideological in the usual sense of the term…but because they are intrinsically adjusted to serving a social order that ignores potentialities and views being as the stuff of domination" (p. 180).

Reification has been intertwined with the concept of *technology* since the concept was first developed in the 1930s and continues today through contemporary discourses of disruptive innovation in which technologies are decontextualized from messy social and historical relations and reduced to pure function. Function, in turn, is taken to be the autonomous driver of new and emerging sociotechnical relations that are decontextualized from the rich web of culture and history that permeates our everyday lives. Again, referring to ride-sharing platforms, Eric Schmidt, the former executive chairman for Google, argues in a short essay titled "Embracing a New Digital Era in Europe" that:

> Europe needs to accept and embrace disruption. The old ways of doing things need to face competition that forces them to innovate. Uber, for example is shaking up the taxi market – for the good. It offers riders convenience and cheaper fares, Understandably, the incumbent taxi industry is unhappy.[6]

Schmidt presents a definition of transportation in which it is reduced to the functional capabilities of software applications oriented towards more convenience and cheaper fares for consumers. Questions about regulations that guarantee passenger safety or labour relations that aim to provide security for drivers are not accounted for because these questions fall outside the scope of technical function.[7]

The work of Christo Sims (2017) is also interesting in this regard. Through an ethnographic study of New York's "Downtown School," which was lauded as a technologically cutting-edge philanthropic intervention to disrupt education for the twenty-first century, Sims discovered that concrete attempts to realize disruptive innovation reified class and power relations through reliance on deterministic notions of technology's social autonomy. Embedded class and race relations were not accounted

[6] This essay is part of a series that was sponsored by the European Commission called Digital Minds for a New Europe. Available at: https://lisboncouncil.net/publication/publication/118-digital-minds-for-a-new-europe-.html (Accessed 16 June 2019).

[7] Uber, for example, was banned from London because it failed to meet regulations concerning a "fit and proper" transportation service. As was reported by Transport for London, the regulating body for transport in the city, "Uber's approach and conduct demonstrate a lack of corporate responsibility" in relation to reporting serious criminal offences, obtaining medical certificates, and driver background checks.

for by those who argued for technical fixes for educational problems. Studied in messy and complex real-world settings (especially public institutions like schools and hospitals), it becomes obvious that disruptive innovations are co-constituted with, not distinct from, embedded power relationships regarding class, politics, and socio-economic status.

FEAR AND DISRUPTIVE TECHNOLOGY

The idea of reification resonates across many different concepts of *technology* from the 1930s to today. What is unique to a disruptive conceptualization of *technology* is fear. The connection between fear and disruptive innovation has been pointed out by Joshua Gans (2016) who writes that, "following the dot com bust and 9/11, the world's managers were receptive to a message of fear." Jill Lepore (2014) also recognizes this dimension of disruptive innovation, noting that it is, "…competitive strategy for an age seized by terror… It's a theory of history founded on a profound anxiety about financial collapse, an apocalyptic fear of global devastation." There is much that can be taken from this culture of fear. Lepore's insights, for example, draw out an idea of history implicit in the theory of disruptive innovation in which continuity with the past is subsumed within an intense present of complex and inscrutable forces continually disrupting any collective understanding of history.

In the following, I want to use the insights of Gans and Lepore as a starting point from which to develop more analytical clarity by drawing out a distinct variation of fear. Fear, after all, plays different roles across different ideas of technology: fear of losing human agency and independent thought against an autonomous technology (Heidegger, 1977 [1953]; Marcuse, 1964; Winner, 1977), fear of technology's existential threats (Bostrom, 2014), and fears of unintended consequences (Jonas, 1984), to name only a few. In the case of disruptive innovation, it is a fear of falling behind that shapes, and is shaped by, expectations of technological development and the pace of technological change.

The essay "It's Time to Disrupt Europe" (Chatterjee, 2014), which was collected alongside Schmidt's pleas for Europe to embrace disruption, begins with an ominous warning that "Change is not a luxury but mandatory. The alternative is significant loss leading to oblivion." Concretely, this is manifested in a number of different cases, such as when municipalities and cities feel compelled to invest in technologies considered disruptive, such as blockchain or autonomous vehicles, on the premise of not falling behind. Similarly, the narrative of the "New York Times Report on Innovation" (2014), which drew heavily on the theory of disruptive innovation, begins with the claim that "we are falling behind at the art and science of getting our journalism to readers" (p. 3). This fear of falling behind, though, does not exist in a vacuum; it is a response to, in this case, a frantic media landscape: "the pace of change is so fast that solutions can quickly seem out of date" (p. 58).

The Joint European Disruptive Initiative (JEDI), a French-German public-private initiative, exemplifies this fear of falling behind alongside an intense pace of technological change. JEDI was promoted as providing the resources for what its director André Loesekrug-Pietri calls "moonshots," high-risk and high-reward technological breakthroughs that require public funding so as to not be subjected to unpredictable market forces or policy changes; or, as Loesekrug-Pietri put it in a speech before the working group designing a new Élysée Treaty, "projects that are massively risky but that could potentially completely disrupt an industry and/or lay the technological foundations for a completely new sector."[8] The motive behind these ambitions can be read in the declarations of its proponents: "Europe is losing footing on all fronts…time is of the essence and the goal is to stay ahead of the game rather than follow where others lead…Disruption used to be luxury. Today it is essential to survive."[9] The rhetoric of fear is intertwined with a mindset of accelerated sociotechnical Darwinism in which speed,

[8] Available at: https://www.bundestag.de/blob/556394/ff7f0a1f37e43041096 1b15ceb58e2b4/3--jedi-en-fr-data.pdf (Accessed 16 June 2019).

[9] These quotes are taken from Loesekrug-Pietri's speech before the working group designing a new Élysée Treaty

anxiety, and intensity are necessary for survival. While Loesekrug-Pietri announces that "What matters is speed…be the one that sets the speed and you will set the norms. If Europe doesn't change its rhythm it will become irrelevant," French President Emmanuel Macron pushes for an imperative to move fast so as to not be left behind, "we are not in the middle ages, we are in the global race."[10]

It would be difficult to claim that JEDI (or many other contemporary articulations of disruptive innovation) adheres to the original theorization of disruptive innovation. Yet, there is not a complete and total break with Christensen's work occurring across these disruptive initiatives. Both formal and informal theories of disruptive innovation share an idea of technology that can be found in the empirical work upon which the theory was first developed.

The theory of disruptive innovation grew out of Christensen's interest in why smart, successful, competitive firms fail. He addressed this question through the hard disk drive industry because the rate of change in this industry was so fast and so unrelenting that one could study business cycles over months that in other industries would take years: a kind-of drosophila for management theorists. Christensen's original hypothesis was that the disk drive industry consisted of firms that, although successful, inevitably failed because they could not keep up with the pace of technological change. Christensen called this the technology mudslide hypothesis: "coping with the relentless onslaught of technology was akin to trying to climb a mudslide raging down a hill. You have to scramble with everything you've got to stay on top of it, and if you ever once stop to catch your breath, you get buried" (1997, p. 8). Research revealed that this hypothesis was incorrect. Neither the pace nor the complexity of technological change led firms to fail. In some cases, incumbent firms not only managed to stay on top of technological change, but also managed to prosper and grow when confronted with change. However, in other

[10] Available at: https://www.bloomberg.com/news/articles/2018-03-27/european-technology-irrelevance-feared-as-u-s-china-dominate (Accessed 16 June 2018).

instances of technological change these same firms to failed. The problem was not technological change per se, but distinguishing between sustaining and disruptive technological change. In the disk drive industry, markets where technological change was characterized as sustaining, incumbent firms tended to prevail. When disruptive technologies were introduced, these same firms tended to fail (Bower & Christensen, 1995; Christensen, 1997).

In the disk drive industry, customers valued memory and processing speed and so sustaining innovation were directed towards increasing and accelerating these functions. In the late 1970s disk drive industry, the market was dominated by firms that produced 8-inch drives with storage capacities between 10 and 40 MB (which increased along a trajectory of 40% MB per year). The consumers of these disk drives were manufacturers of minicomputers, objects that because of their price and size were largely restricted to consumers such as the state, industry, and universities. In 1980, a 5.25-inch drive was introduced that had a storage capacity of 5 to 10 MB, which were of no use for minicomputer manufacturers who, following a trajectory of sustaining technologies, required 40 to 60 MB drives at this time. The 5.25-inch drive, though, had attributes (size, price) that appealed to a new market, personal computer manufacturers. In this case the 5.25-inch drives "offered a different package of attributes valued only in emerging markets remote from, and unimportant to, the mainstream" (p. 16). In time, firms that manufactured 8-inch drives were supplanted by firms that manufactured the 5.25-inch drives because the memory capacity of these latter drives improved such that customers of the 8-inch drive found the 5.25-inch drive more appealing (Christensen, 1997, p. 20-21).

Over the course of the past twenty years, Christensen has refined his theory in different ways. What has stayed the same, though, is Christensen's "technological mudslide" hypothesis. Although his original instincts about how firms dealt with this mudslide were incorrect, the assumption that the landscape of technological change

could be equated with a mudslide remained consistent across the theoretical history of disruptive innovation. By selecting the disk drive industry as the basis of a theory of technological change, Christensen built his theory on the presumption that the pace of technological change is not only fast, but, in his own words, "pervasive, rapid, and unrelenting" (1997, p. 3). This assumption, which has had had a decisive influence on contemporary decisions and attitudes about technology, has become normalized across different articulations of disruptive innovation, contributing to an idea of *technology* in which fear of falling behind or being left behind has emerged as the logical, and necessary, corollary to these expectations about the pace of technological change.

CONCLUSION: CONTESTING DISRUPTIVE *TECHNOLOGY*

Considering the idea of technology as an object of study may seem a holdover from the more obscure ends of metaphysical speculation. However, work by conceptual historians and philosophers of technology has pushed scholarship towards more empirical ends through an attention to the processes by which particular artifacts become categorized as technology. This research demonstrates that there is no inherent distinction between those objects that count as technology and those that do not, nor is there any inherent distinction between those vocations or types of knowledge that are valorized as technological and those that are not.

The concept of disruptive innovation can serve as a useful heuristic through which to trace the outlines of the artifactual and bounding processes that have shaped new ideas about technology over the past decade. Artifactually, technology is not what it was when the concept was developed nearly a century ago. Railways, dams, airplanes, and bridges no longer seem to count as technology. A loose survey of recent headlines categorized as technology in newspaper refer to Google, self-driving cars, emojis, hacking, cyber-security, twitter, bitcoin, uber, foodtech startups, Spotify, Silicon Valley, smart houses, Facebook, and Snapchat. The idea of technology, as I have attempted to argue in the

preceding paper, is not only artifactual, but also refers to the question of what we do when we envisage the world with a technical intention. Examining disruptive innovation in this way allows for insights that move away from debates about theoretical consistency or cynical remarks intended to deride the concept in order to better trace the intentions and expectations that precede our engagements with technical artifacts and technically mediated processes.

Any specific ideas of technology, though, need not be our fate. Technology is contingent at both the hermeneutic level and the level of design. Recognizing how an idea of technology emerges through the development of a concept like disruptive innovation can be the starting point to begin thinking about technology in ways the prioritize fears other than falling behind technological change.

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