THE WORLD IN THE SCREEN: HOW THE MOBILE DEVICE SYMBOLIZES TECHNOGENESIS

by

Joel Mathew Morrow

THESIS

Submitted in partial fulfillment of the requirements

for the degree of Master of Arts in English at

The University of Texas at Arlington

December, 2016

Arlington, Texas

Supervising Committee:

Timothy Richardson, Director

James Warren

Cedrick May

ABSTRACT

The World in the Screen: How the Mobile Device Symbolizes Technogenesis

Joel Mathew Morrow, M.A.

The University of Texas at Arlington, 2016

Supervising Professor: Timothy Richardson

The smart phone, or mobile device, holds a preeminent role in a technologically advanced society. These devices allow for connection, productivity, and distraction, and in doing so create new anxieties and underscore old ones. By tracing the provenance of this artifact, we see how our relationship with mobile devices amplifies our relationship with technology as a whole. This thesis examines the development of the mobile device from the viewpoints of social constructivism and technogenesis to illustrate how our increasing intimacy with these devices is part of a long-standing pattern of co-evolution between humans and the technologies they create.

DEDICATION

I dedicate this thesis to the following people, in appreciation of all their support and encouragement:

To my incredible wife Lindsay, for all of her unwavering support during my studies.

To my parents and sister, for instilling in me a love of reading and writing.

To Dr. Lynn Hoggard and Professor James Hoggard, for their impassioned teaching and guidance.

Table of Contents

Introduction

The change in meaning from the now-anachronistic term “cell phones,” to the profligate “mobile devices” illustrates a perceptual shift around technology in general, and these devices in particular. Long past are the days of brick phones, flip phones, two-color screens, and the limited functionality of the cell phone era. Mobile devices, a term that includes but is not limited to smart phones, are scalable in functionality, limited only by their hardware. It is significant that mobile devices are the latest in a line of commercially available technology to be designed with more than one function in mind, firmly placing their lineage in parallel with personal computers. To be sure, they can make calls and send texts, but beyond these basic functions the application of the device can take any number of forms. The proliferation of applications, available in a centralized hub unique to the device’s operating system, allows access to a slew of programs to distract, increase productivity, and foster creativity. The Google Android and Apple iOS operating systems, which share the majority of the market between them, allow for anyone to publish applications, so long as their product survives an approval process. This crowd-sourced content delivery means any hobbyist developer can cobble together some code, publish it, and share (and perhaps even profit from) their work.

The parallels that can be drawn from the mobile device revolution to a similar technological turn, that of personal computers, are inescapable. Computers evolved from advanced analog calculators, and were the products of intense, experimental engineering. Machines like Bletchley Park’s Colossus were used for military code-breaking applications, while the University of Pennsylvania’s ENIAC was the first to use digital computing, a concept that inflamed public perception of the potential of computers ("Timeline of Computer History"). Still, these monstrous computers were not designed with the user in mind, but only the end product. ENIAC, for example, was designed to calculate firing solutions for artillery. To use this computer, massive function tables, which served as RAM, had to be painstakingly programmed to perform the desired operation, rolled to the proper terminal, and then plugged into the system. Even though ENIAC was designed with one purpose, once its operators had a better grasp on what the device could actually accomplish, they used it for more and more kinds of calculations. Edward Teller, for example, used ENIAC to help model nuclear reactions ("Computing and the Manhattan Project"). A mobile device, a product so far removed from the modest beginnings of the computer era, is designed with ease of use in mind, leading to greater consumption of both devices and media.

Prioritizing the user makes mobile devices more accessible. By keeping the functionality of the device largely the prerogative of the user, mobile devices are being used not just for communication, but also for media consumption, fitness tracking, and workplace productivity. The semi open-ended nature of these devices leaves a sizeable space for additional avenues of subject-object interaction. Additionally, these added levels of interaction have in turn propelled the development of these devices, as users find elements of the device that they like and those they do not.

Sigmund Freud, Karl Jaspers, Jacques Ellul, and Martin Heidegger all expressed anxieties and deep reservations about technology. They feared the dehumanizing force represented by the mechanical, and would perhaps fear even more the ideas of software automation, self-driving cars, and the panoptic eye of the mobile device. Heidegger in particular illustrates one of technology's traps, of growing so accustomed to using devices to measure and alter the material world that our focus makes us lose sight of ourselves. These writers serve to establish the more traditional conception of technology and of technological evolution, while their worries about the field actually point to some of the more intimate components of technogenesis.

The theory of Social Construction of Technology (SCOT), as put forth by sociologists Wiebe Bijker and Trevor Pinch, focuses on the user experience, and systematically charts the interactions of relevant social groups with a technological artifact. Also referred to as social constructivism, their process identifies an artifact and the relevant social groups that use that artifact. They then delineate the varying issues those groups have with that artifact, and how those issues prompted some minor change. The incremental process thus outlined allows for a relatively comprehensive developmental history to be compiled and analyzed, which facilitates a review of gaps in the market. By analyzing mobile devices through Bijker and Pinch's methodology, we can point to historical patterns of interactions with cell phones and other mobile devices.

It is not only the actions of the past that drives these relationships. Bernard Stiegler, Kevin Kelly, and N. Katherine Hales all point out the phenomenon of "technogenesis," the concurrent evolution of humans and technical artifacts in ways that directly correspond.[1] The more organic processes they outline allow not only room for industries to respond to customer needs and desires, but also to provide a space for individual subject and object correlation. With this reciprocity in mind, how then, can we view technological development as a force that grows and evolves alongside humans, as well as a procedural resolution and generation of needs and wants? This disconnect, I contend, points us to the conclusion that our relationship with technology is at once both organic and synthetic, enveloping the physical and psychological drivers that shape us and our world, and must be contemplated as a field that is itself a cyborg.

Chapter I

Alienation In Utopia

To frame the issue at stake, we can turn first to Freud. In *Civilization and Its Discontents*, initially published in 1930, Freud discusses the anxieties surrounding technology, and his analysis of these anxieties parallels the developmental cycle. Freud's misgivings about technology center on their tendency to create more problems than they solve. His most germane example in the terms of communication is still surprisingly relevant:

> If there had been no railway to conquer distances, my child would never have left his native town and I should need no telephone to hear his voice; if travelling across the ocean by ship had not been introduced, my friend would not have embarked on his sea-voyage and I should not need a cable to relieve my anxiety about him. (17)

In this musing, the primary concerns, or worries, of distance and communication are magnified because they each manifest in the other. If relatively cheap and fast ways of travel had never arisen, communication over vast distances would be similarly moot. Freud misses talking to his son, and worries for his friend's safety, while simultaneously ruing that the same spirit of technological advancement that took them away created these anxieties. This is the same kind of reciprocal affect that we can find in technogenesis, where technology influences the user, and the user influences the technology. Freud's focus on the anxieties thus created signals a deep unease about the expansion of the subject into the exterior, as well as the feeling of alienation thus created, this time as a projection of technical artifice.

Later on in *Civilization and Its Discontents*, Freud references the "oceanic feeling," a term he borrows from his correspondent Romain Rolland, as a sense of disembodied connection of interior and exterior realities. Freud remarked that he had no experience with this sensation, but likened it to a kind of religious or spiritual field. He details how Rolland described this feeling as the wellspring of "religious energy" that enables a mindset where the self and the exterior reality were inextricable (Freud 1). Where the sense of unity afforded by this experience is largely discussed in terms of faith or spirituality (the appropriated buzzword "mindfulness" could perhaps be an example of this), I contend that an alternative reading could just as easily apply to Freud's aforementioned technological angst. Freud's son and friend are penetrating the social consciousness of their hometown, exceeding their horizons and moving into social otherness. The magnified proximity eliminates the visceral connection, and only allows a mediated one, a distorted voice on a '20s era telephone, or a few pasted lines on a telegram. While Freud acknowledges the miraculous nature of these innovations (later on in *Civilization* he writes with wonder that the telephone allows for communication "at distances which would be respected as unattainable even in a fairy tale…,") that admiration has an inversely negative effect on his mental ease (18).

Freud was certainly not alone in expressing misgivings about the usefulness of technological innovation, particularly on the subjects of railroads. Ralph Harrington, writing on the deep distrust of rail travel held in 19th century England, cites numerous reports from contemporaneous newspapers on this issue. Harrington, with great vividness, describes this anxiety: "[railroad accidents] crystallised in a single traumatic event the helplessness of human beings in the hands of the technologies which they had created, but seemed unable to control; it was a highly public event which erupted directly in the rhythms and routines of daily life; it was no respecter of class or status; it was arbitrary, sudden, inhuman, and violent" (Harrington 2003). Harrington describes a much more visceral fear than Freud, a fear of violence, injury, and death as a result of faster travel times.

While Freud does share some of this concern (after all, he was worried for his friend's safety after a long sea voyage), his is a more cerebral trepidation of the lack of truth in the technological ideal. Harrington's research puts hapless travelers into the iron jaws of a power they have unleashed but cannot control. Harrington then quotes an 1857 edition of *The Lancet* expressing fury that railroads "specially maintain, in a series of by-laws, their right to slay, smash, mutilate, or cripple their unlucky passengers…," thus providing us a capitalistic lens through which to view this anxiety. The outrage expressed in response to railroad accidents was borne largely of the public's view that they could be avoided. Improper governmental regulation and railway companies that skimped on safety equipment and procedures added an economic fuel to the simmering discontent. The establishment of Lord Campbell's Fatal Accidents law in 1846, which provided legal grounds for victims and survivors of accidents to sue for damages, presented an economic challenge for the railways.[2] While they staved off some of the litigation by discrediting the purported victims, large payouts were still made, and a surge in this kind of legal suit followed (Harrington 2003). Legislation in 1871 provided for railway inspectors and allowed for greater governmental oversight of line and engine maintenance.[3] Again we see a pattern where technology creates problems while simultaneously resolving others. The musings of Freud find an ally in the hard data of Harrington, underscoring a sense of anxiety about the technological utopia.

The propagation of cellular networks, mobile data, and mobile devices has resulted in an unprecedented amount of data collection and communication. Now, I can call for assistance if my car breaks down on a desolate highway. I can track my runs and use the data to try and improve my pace. I can clearly recall having a crossword puzzle app on my mobile device as my only source of diversion while anticipating potentially dire news in a hospital waiting room. However, the threats of mobile surveillance, exploding phone batteries, and fatal distractions are some of the more recent problems that were not nearly so prevalent prior to the development of the mobile phone. Freud's worries and Heidegger's warning are as relevant as ever.

The technological utopia, or the technological ideal, is a vision of the future where the pursuit of technological progress has resulted in a post-want society, a *Star Trek* future where technology is the harmonious, seamless linkage between humans and their environment. The problems technology has promised to solve are long in the past, and all that remains before a unified human race is to explore, to learn, and to live.

While this concept is described by Howard Segal in "The Technological Utopians," it is less an academic concept and more the product of a culture perpetually enchanted by the promise of technological progression. It is a seductive world where machines and algorithms have freed us from menial labor, disease, poverty, war, and scarcity. Novels like Paul Devinne's 1907 work *The Day of Prosperity* or Edward Bellamy's 1895 piece *Looking Backward 2000-1895* describe societies of perfection and egalitarianism, all thanks to the progressive forces of technology (Segal 20). Cultural artifacts such as these (Segal tells us that Bellamy's work in particular was hugely popular) had such an effect that Segal posits that "a growing number, even a majority of Americans…" believed "in the inevitability of progress and in progress precisely as technological progress (1). I mention Segal and the technological utopia to provide a contrast to the worries of Freud, and to acknowledge the existence of a sentiment that urged hopefulness in the face of progress. It is obvious that the technological ideal has yet to be achieved, and it seems dubious that it even can be achieved. The trust placed in technical progression, which I believe still holds a firm grasp on many, can still be shown as a key factor in the development of new technologies.[4]

Civilization and Its Discontents can be read as cynicism towards the technological utopia. Freud expresses serious misgivings about the net benefits of technology, but he can't help but be entranced by it. One section in particular reads almost like a paean to the wonders he's seen:

> With every tool man is perfecting his own organs, whether motor or sensory, or is removing the limits of their functioning. Motor power places gigantic forces at his disposal, which, like muscles, he can employ in any direction; thanks to ships and aircraft neither water nor air can hinder his movements; by means of spectacles he corrects defects in the lens of his own eye; by means of the telescope he sees into the far distance; and by means of the microscope he overcomes the limits of visibility set by the structure of his retina. (18)

Freud here makes an offering to the technological. The litany of real-world accomplishments he recites echoes some of the ideals envisioned in the technological utopia. Humanity unfettered, unshackled by the flesh, and using their collective intellect to craft their world into shape at their own direction. He also voices a more classical interpretation of technology-as-tool, as an extension of the hand, arm, leg, ear, and eye. Mankind has become, in his famous terminology, a "prosthetic God" (Freud 19). Agency is not the artifact but agency moves through the artifact. Heidegger, in his essay "The Question Concerning Technology," provides a dissenting voice to this concept, arguing that technology should not be viewed merely as a teleological construct but as an opportunity to quest for greater understanding of existence.

To Heidegger, the applications listed by Freud subvert the search for truth as they interfere with that truth being revealed to us. We use technology to plumb the depths of the natural world and to enhance our understanding of everything we experience. The human proclivity for quantification and labeling Heidegger calls "enframing," or *Gestell*. Enframing is "the illusion [which] comes to prevail that everything man encounters exists only insofar as it is his construct" (Heidegger 332). It is a "setting-upon," alternatively a "mode of unconcealment," of the natural world in a way that actively uncovers it.[5] Heidegger argues that this kind of "setting-upon" has altered our perception of reality for the worse, as there is the tendency to focus too closely on technology for the sake of measuring and calculating, but not to consider the potential ramifications of this behavior, namely, becoming enslaved to it. In "The Memorial Address," Heidegger expands upon the dissonance, and offers a way to resolve it, that he exposes in "The Question Concerning Technology." Through *Gelassenheit*, releasement, Heidegger claims that we can co-exist with technology in a way that does not entrance. Progress, for Heidegger, can only come out of thoughtful and considerate application of technology, a model which is undercut by capitalism and conflict being some of the primary developmental drivers.

Both Freud and Heidegger assign a surprising amount of dynamism to the concept of technology. Freud's paean grants humanity the power of flight and limitless strength though the vector of technology, and for Heidegger, the obvious use of technology is one of "challenging-forth" and "setting-upon." This is a counterpoint to the technology-as-tool approach, one that underlines that the truth of technology is not what it lets us do, but how it lets us re-envision reality.

The idea of technology-as-tool, so derided by Heidegger, is grounded in practicality, but it is a practicality that Freud overcomes, as he reads technology as memory. Just as Freud was unsure of the "oceanic" feeling, he too is unsure about technology. The advantages they afford seemed outweighed by the new problems they created. His example of his loved one's lack of proximity, and of the strained connections afforded by technology, gestures to his unease of moving past the interior (in this case, the social circle of his hometown) to the exterior (anywhere far removed from there), and his feeling that a sense of connection between the two creates more problems than it resolves.

Where Freud states "Writing was in its origin the voice of an absent person…," he evokes an old reference to technology-as-memory, Plato's *Phaedrus* (18). In this dialogue, Plato ironically records Socrates's condemnation of the written word, one of the most powerful technologies ever developed, as an insult to human memory and to the speaker or thinker of the recorded words (276a). Socrates criticizes the written word on its lack of agency, its inability to adapt its message to suit certain audiences, and its lack of defense when challenged. But mostly, he criticizes it for having a deleterious effect on memory. Socrates, in reaction to hearing a written speech read to him by Phaedrus, relates a parable of ancient Egypt concerning the god Theuth and the pharaoh Thamus. Theuth has invented writing, and with great joy presents it to the pharaoh, trumpeting it as an aid to wisdom and memory. Thamus is instead dismissive, informing Theuth that he is blind to the drawbacks of his creation and stating "…it will introduce forgetfulness into the soul of those who learn it: they will not practice using their memory because they will put their trust in writing, which is external and depends on signs that belong to others…"(275a). Freud's concern about distance and communication recalls the same issue of technology solving one problem, just to create another.

Both Socrates and Freud have more stakes in the issue than just ideology: Socrates takes offense to the lack of dialectic afforded by Lysias's written speech, and Freud is emotionally invested in those involved in his own example. This kind of personal involvement will be more adequately addressed further in this discussion, but their mention here allows me to frame my argument around this lingering feeling of technological unease. Discomfort and dissatisfaction with technology are excellent entrance points to discussing technological development, as the developmental process is heavily dependent upon the kind of feedback effect that so concerned Freud and Socrates. The technological development cycle functions similarly by systematically creating and resolving issues. As will be discussed later, this process is the foundational component of technogenesis. For Freud, the *Star Trek* future –-- one of social harmony as a derivative of technological advancement –-- is an impossible dream, a utopia that would in reality fall prey to Zeno's paradox of progressive dichotomy.[6] However, Freud and Plato help us bracket the discussion of our overall relationship with technology by providing a voice of concern, and by pointing to the ceaseless cycle of new technology fixing one problem but creating another.

Technology is at once a source of optimism and a source of anxiety. The promise of a better life through technological intervention is an incredibly powerful force that is nevertheless tempered by this consistent production of new issues. Freud laments the physical and emotional distance generated by waiting for his absent loved ones to contact him via phone or telegraph. The idealized utopian future crumbles as humanity fails to advance at the same pace as technology. Heidegger's proposal for a "free" relationship with technology comes closest to reaching the untouched heights of the technological utopia, but a mindful, critical approach to development is subverted by capitalism. Heidegger himself sounds a utopian note in his assertion that humanity can fundamentally re-shape their relationship with technology through scientific pursuit. His model allows for manufacturing on an industrial scale, but not for Angry Birds. The mobile device's current level of ubiquity makes it a prime example of Heidegger's dualistic view: it enables communication and access to knowledge on an unprecedented scale while simultaneously providing a source of distraction and mediated social relations. In order better understand how the mobile device came to occupy this frustratingly ambiguous niche we will review its developmental history through the lens of sociology.

Chapter II
Networking the Social

The Social Construction of Technology (SCOT), as mentioned above, is a methodological approach to technological development created by Trevor Pinch and Wiebe Bijker in their essay "The Social Construction of Facts and Artifacts."[7] Their theory provides a concrete analytical model that can be used to chart and trace the development of a particular technical artifact. Their suggested model involves identifying the artifact in question, the various social groups who use or relate to that artifact, and the problems that arise in the course of those interactions. This approach allows us to take the anxieties of Freud and Heidegger, diffuse them into the concerns of social groups, and then see how they apply to technological evolution. However, it is important to discuss briefly the ideas behind a more "traditional" view of technological development, through a reading of Jacques Ellul, so that this analysis has some contextual backing.

From a traditional perspective, technological development is the application of scientific principles to material inventions. It is the creation of a tool that resolves a challenge or difficulty, or an improvement of processes that allows for more efficient work. Jacques Ellul, in *The Technological Society*, writes that technology "…evolves in a purely causal way: the combination of preceding elements furnishes the new technical elements" (97). Ellul's is a sequential and linear process that marches tirelessly from improvement to improvement, driven by human genius and human necessity. Technological progress is not teleological for Ellul; it is a constant refinement of knowledge, and the search for a better application of that knowledge. He centers his theory (which Ellul himself would claim is not theory but fact) on the idea of the technique, which he defines as "the *totality of methods rationally arrived at and having absolute* *efficiency* (for a given stage of development) in *every* field of human activity" (xxv, emphasis his). Ellul's writings communicate that technology cannot be accepted as being either a positive or a negative force, as these two aspects are inextricable from the whole, which as such is monistic.

Relegating the technical to a neutral presence runs counter to arguments further on is this analysis, as it does not consider the non-human forces that can be enacted through technology. For Ellul, technological evolution is solely the purview of human inventors, and thus discussions of technology cannot stray from the social. Karl Jaspers echoes this sentiment with an altogether more dire tone, offering a choice between domination of technology or subservience to it: "[Man] must either on his own initiative independently gain possession of the mechanism of his life, or else, [see] himself degraded to become a machine, surrender to the apparatus" (Jaspers 176). There is a facile connection between Ellul and Bijker and Pinch, as they all point to sociological reasons for the advancement of technology. However, Ellul's philosophical approach to this issue would have been of little interest to Bijker and Pinch, as they lament that philosophers wrote on "overidealized distinctions, such as that science is about the discovery of truth whereas technology is about the application of truth" (13). Bijker and Pinch concern themselves with case study rather than conjecture, and their essay is the most scientific of the ones I analyze. Their highly regimented and systematic approach to the subject of technological evolution is in itself highly interesting. In eschewing conjecture and theory they strive for some essence of the empirical, but framing their argument in this way allows them to succumb to the same lull of linearity as does Ellul. Unlike Ellul, though, they are cognizant of this. One of their primary case studies is Lawson's bicyclette, which is held as the pinnacle of Victorian bicycle design despite being "a commercial failure" (Bijker and Pinch 22). They freely admit that considerations of economy hold less importance to them than the technological steps realized, and allow this focus to skew their methodology.

Despite this, we will see why it is advantageous to apply their model to the development of mobile devices. To describe their model, Bijker and Pinch trace the bicycle's developmental history, from the aptly named Boneshaker model to the safer Lawson's bicyclette, by relating the advances made on each model to the different social groups that encountered them. Earlier and more minimalist models, such as the Penny Farthing, appealed to young, healthy men. These models had few safety considerations –-- minimal brakes, no gears, and no cushioned seats. Bijker and Pinch create a cluster of "relevant social groups" around this artifact, both of ideal users and those who wish to be users but, due to the limitations of the artifact, cannot be. Users in the second category included women (for whom bicycle use was seen as highly improper), children, and older men. Each of these groups related negatively to the artifact in question, and the causes of their relational issues spurred innovation to alleviate them. A major concern of the Penny Farthing was safety, as the vehicle took considerable strength to pedal and maneuver, and with only perfunctory brakes was relatively difficult to stop.[8] Also, the placement of the rider on the bicycle made for a top-heavy, unwieldy ride, and any bump or obstacle could cause the rider to fall. The safety risks associated with these kinds of bicycles grew so pronounced that bicycle salesman developed names for the different ways one could fall off their products (Matthewman 97). These safety worries were then addressed by manufacturers releasing newer models with safety features such as indirect drive, lowered front wheels, spring-assisted frames, and pneumatic tires.[9] Lawson's bicyclette in particular was relatively loaded with safety features, including a diamond-shaped frame, a chain drive, wheels of more equal size, and, perhaps most critically, a relocated seat that provided better balance. The user experience, as demonstrated by

Bijker and Pinch, contributed to the advancement of a particular technological artifact, with the purpose of showing that "…the 'invention' of the safety bicycle was not an isolated event (1884), but a nineteen-year period (1879-98)" (30). In a similar manner, the development of the mobile device is best viewed as a series of incremental steps, with concurrent considerations of niche users and new features.

The potential bicycle users, and more importantly the issues they found with the Penny Farthing, indicate market gaps, and these gaps functioned as an indirect method of communication with bicycle manufacturers. Solving issues with the initial artifact allowed for more relevant social groups to purchase and use the improved artifact, incentivizing manufacturers to continue responding to the concerns of their users. Moving beyond the economic, the SCOT methodology shows a more traditional pattern of technological development, one where human agency is the impetus for all change. Addressing the social role in an artifact's development injects into the process a more diffused anthropocentric viewpoint. A similar methodology can be applied to the history of the mobile device, and through this application we will see that, while this artifact has far too complicated a history to be easily reducible, the interplay between advancement and user experience becomes more readily apparent.

The mobile communications device finds its earliest roots in the ideas of Guglielmo Marconi, a British-based Italian inventor. Marconi developed a wireless telegraph device that sent and received signals via broad-spectrum radio. Marconi sold his device to the Royal Navy, who installed them on battleships. The advantage was considerable, and Jon Agar credits these devices with a pivotal role in the Battle Of Jutland.[10] Receiving telegraphs while still at sea, theoretically, enabled Royal Naval vessels to coordinate with ground-based installations and forces, enabling them to react quicker and to navigate through inclement weather.[11] The problems, though, were equally profound. Marconi devices were massive, and Agar posits that Marconi had found one of the few organizations with large enough vehicles to house and transport the devices Additionally, Marconi's transmitter required a staggering amount of power, and battleships were some of the few ships afloat that could meet their power needs. Agar relates: "Radio transmissions in the 1900s had been achieved by creating bursts of sparks generated by immense electrical voltages. (The same principle is behind the crackling interference caused by lightning)" (5). The Battle of Jutland shows that these early types of radio communications where prone to interception and jamming. While an undeniably valuable artifact, Marconi's mobile telegraph had issues that only a narrow subset of potential users could overcome.

The mobile telegraph spurred technological innovation, and other inventors explored ways to resolve its largest problem –-- the battery. Guy Klemens tells us that Benjamin Franklin, after developing a version of the Leyden jar, which was one of the earliest operable batteries, called his electrical storage device a battery after remarking that the glass-paned segments of the device had a similar function to a naval magazine (182). Current battery technology for mobile devices uses a lithium ion battery, but the piece of technology most responsible for inaugurating the era of mobile technology was the nickel metal hydride (NiMH) battery. First researched by the Prussian Walther Nernst in 1899, this battery was gradually refined until it could be easily incorporated into and reliably power mobile devices, a development that Agar says "triggered our mobile world" (6). By 1890, the battery had changed from the bulky wet cell battery to the safer and smaller dry cell type. Further significant advances were made in the sixties and seventies, as small batteries became rechargeable and more capable of providing a single, consistent voltage (Klemens 183). The revolution of the battery, perhaps more than any other technology, has allowed us to decouple technology from the grid, granting us invaluable opportunities to use increasingly sophisticated technology in an increasingly varied number of places.

The importance of the battery shows that the most stubborn obstacle to truly mobile electronics was the amount of power these devices required. Marconi's wireless telegraph required a ship-borne power plant to run, and Lars Magnus Ericcsson's first speculative forays into mobile communications resulted in a car phone that had to be connected to a telephone or telegraph pole, and a hand crank turned to generate enough power to produce a signal. While this device was never intended for public consumption, it would have made mobile phone calls an interesting experience. Ericcsson's wife would have to stand outside the car, holding antennas to the line, while Ericcsson himself worked the crank that generated enough voltage to allow them to reach the nearest signaling station (Agar 6). While advents in the battery eventually surmounted this particular hurdle, there was still a great deal of work to be done to capitalize on radio-based communications.

Other wireless technologies flowed from Marconi's wireless, and in keeping with the Royal Navy's use of the wireless telegraph aboard battle ships, many of them were used in a military capacity. After the Admiralty of the Royal Navy decided to install Marconi's devices in their ships, other facets of the British military began to take notice. According to Jill Hills, Marconi devices were shipped to South Africa during the Boer War to improve communication between ground forces and their supply vessels. Hills goes on to describe their relative lack of success: "The army mounted the wireless transmitters on horse-drawn carts and sent the Marconi company's employees into the field, only for the antennas to fail in the high winds" (96). This failure appears to have been anomalous, as even afterwards the British military continued ordering wireless telegraphs from the Marconi company. World War II saw the United States military complex roll out the SCR-300, a massive wireless radio that was lugged around on the operator's back (Sterling 504). This device was bulky and difficult to use, while simultaneously being an invaluable battlefield resource. Refining its design led to the SCR-536, a handheld version of the SCR-300. This smaller version, often referred to as a "handie –talkie" was still not small, being about a foot long and weighing six pounds (Yenne 32). William Yenne also tells us, crucially, this device was marketed for civilian use after the war, and while it was not a telephone, it was still an important step towards the advent of the mobile device. Interestingly, the SCR-536 bore a strong resemblance to the DynaTac 8000X. These two devices retained a military user base similar to Marconi's wireless, but addressed several of its key issues, most notably that of portability.

Marconi's wireless telegraph worked, as has been previously noted, by using massive electrical charges to generate bursts of radio waves. In terms of contemporary communications technology, this method is about as reliable as shouting across a crowded and noisy room. The person you want to hear you most probably will be able to, but they will have to sort your voice out from the dozens of other conversations occurring at the same time, and as such might not hear the whole message or confuse bits of other messages with your own. To counter this particular problem, which was found among a small but growing group of users, an international code of regulations had to be adopted. The International Telegraph Union was created, and at their formation one of their most crucial responsibilities was to partition up the increasingly limited slices of the communications spectrum. According to Agar, "To find the radio stations found on 1920s bakelite sets, the listener had tuned to up to a few hundreds of thousands of

Hertz…. During the Second World War, the demand for better radios and the development of new technologies such as radar had ramped the useable frequencies up to many millions of Hertz" (Agar 9, 12).

As technology improved, radio transmitters were able to select finer and finer strands of the EM spectrum, allowing more and more frequencies to be used without interference. There are, however, only so many extant frequencies to use, no matter how thinly sliced. This new problem facing the mobile device user, then, is how to secure a frequency for your own use without thousands of people across the country trying to use that same channel? The answer came in the form of an internal Bell Labs memorandum authored by an engineer named D. H. Ring, which was initially distributed in December, 1947. Ring describes a system of hexagonal or circular cells, or small swathes of land, each covered by a "base station," the precursor idea to the cell tower. In each cell, there would be a much smaller number of active frequencies that would be assigned to each mobile device that was within or was passing through that area. The idea at the time of the memo's publication was that these mobile radio units would be based in cars, so travelling signals were specifically addressed. Ring's idea was to have each base station broadcast a small number of frequencies at relatively low power, to limit their range, and to have sequences of seven cells laid out in sequences. A user could enter cell C, travel to cell B, then down to cell E, and then to another B, all while using their car-based transmitter and with the system silently shunting the call from frequency to frequency. A system like this provided an innovative solution to the frequency log jam that was expected to occur.

Overcoming this particular issue opened mobile communications technology to a huge number of new users, not only resolving the problem but, from a SCOT perspective, drastically increasing the number of relevant social groups that could use and relate to mobile communications technology. The kinds of social groups, while historically very narrow, has expanded into almost all contemporary social strata. The early days of mobile communications technology was limited along racial and economic lines; a subscription to the IMTS system in the 1940s cost $15 per month, which, when adjusted for inflation, is a staggering $175, which does not include the additional charge levied per call ("The Foundations of Mobile and Cellular Telephony"). The extreme cost associated with a technology that was then little more than a luxury strictly relegated the relevant social groups to those of means, which, in that era, meant educated white people with a wealthy socio-economic background ("Chartbook of Social Inequality"). Along contemporary lines, mobile device development accelerated far faster than anyone projected. A 1983 study forecasted 900,000 cell phone subscribers by 2000, but this subscriber count was reached only four years after publication of that study. The actual number of cellular subscribers in 2000 was close to 109 million, a dozen times over the predicted amount ("The Foundations of Mobile and Cellular Telephony"). Rapacious demand for these products necessitated faster development of cheaper and more advanced mobile devices, which in turn enabled access for far more than a privileged few. A strong inference is that increasing the number of relevant social groups has a corresponding effect on the speed of improvements made to an artifact, and that in the more extant social groups available, the quicker the artifact advances.

While the infrastructure for Ring's proposed system would not exist for decades after the memo's publication, it highlights the fact that the SCOT model cannot be viewed from a linear perspective. Bijker and Pinch point to this weakness in what they call the "quasi-linear development model" of technology (Bijker and Pinch 22). It is difficult to extricate the linearity of technological development from the SCOT model, but it is also not the intention of the authors to advocate against chronological comparisons -- they simply ignore it. The only focus of the SCOT model is tracking development through the resolution of issues that relevant social groups associate with a given technological artifact. When applying this concept to Ring's proposed cellular network, it is evident that, at its origination, there were far more problems than could be surmounted through relevant social groups. The entire communications infrastructure needed to move away from increasingly crowded frequency spectrum of IMTS, which would not occur until decades later. IMTS, which stands for Improved Mobile Telephone Service, added greater feasibility to mobile communications technology, but was still severely limited. The AT&T corporate history website shares this anecdote, "…2,000 subscribers in New York shared just 12 channels, and typically waited 30 minutes to place a call. It was wireless, but with 'strings' attached." SCOT does a poor job predicting technologies, as it relies on incremental advances to show a cohesive developmental flow –-- it shows steps taken, not leaps to be made.

To chart out the development of the mobile device in the same way that Bijker and Pinch treat bicycles would require an inordinate amount of space and paper, so I will settle for a written description of such a setup. Our artifacts, in general terms, would start with Marconi's wireless telegraph, flow through mobile radios such as the SCR-300 and SCR 356, and then diffuse into a spider's web of various cell phone and mobile device models. Our relevant social groups would undergo a similar sort of diffusion, just on a more massive scale. Initially, they would be relegated to military interests, like the Royal Navy or the U.S. armed forces. They would then slowly expand socio-economic strata, starting at the top, as the technology and services got progressively more affordable. There would be almost no limit to the number of contemporary relevant social groups that either use or desire to use the mobile device. Kevin Kelly even points to its use in famously anti-technology groups like the Amish (224).

Our issues and resolutions would be most likely impossible to chart, as numerous and self-replicating as they are. Among the many possibilities, the four main technical issues (I am consciously delaying discussion of the social and psychological issues for a later chapter) I deduce are similar to those discussed above: size, power consumption, transmission method, and frequency spectrum. Marconi's wireless telegraph consumed an enormous amount of power and communicated messages about as well as a note written on a paper airplane (after all, anyone could intercept your signal, just as anyone could snatch your missive out of the air). The SMR series of radios were actually portable, but still suffered in terms of weight, battery life, and effective range. With the advent of cell phones, weight and size became more a question of aesthetic and design, rather than an outright inconvenience.

However, new issues cropped up, including memory capacity, signal clarity, and receptivity. Mobile data networks and SMS capabilities in turn pointed out the inadequacies of a phone's keypad in composing text, as well as those of the small, two color screens that displayed that text. Increasing the screen size and adding Bluetooth and GPS capabilities resulted in a perennial assault on battery life, indicating that the battery is one issue that will most likely never be resolved to our satisfaction. This tendency to work itself into a causal loop is perhaps an unintended strength of the SCOT methodology. While it is difficult to actually plot much of this out on paper, the mere idea of doing so is a convoluted enough thought process that we are indirectly reminded of the complicated and laborious nature of technological evolution.

SCOT can be criticized for neglecting the individual, for being too concerned with empirical rigor than with attaching any kind of ontological heft to the introduction of a given technological artifact into society. Langdon Winner accused adherents of SCOT of this by saying, "what the introduction of new artifacts means for people's sense of self, for the texture of human communities, and for the broader distribution of power in society –-- these are not matters of explicit concern" (368). A certain kind of tunnel vision can surely be attributed to SCOT, or as Winner designates them, social constructivists. The question of erroneous (or, perhaps, misattributed) magnification also arises, such as in Bijker and Pinch's earlier bicycle examples. By pointing out that their visual model flows from to Lawson's bicyclette as its end point, making it the pinnacle of the artifacts discussed, ignores the fact that the bike saw limited distribution and did not sell well. Bijker and Pinch assert that they are interested in nothing but how their process indicates the socialized nature of technological evolution, but in doing so they leave untouched the critical developmental role played by capitalism and economics. Additionally, a question of endpoints is brought up. Both Dick Pels and Michael Khoo point to the fact that relevant social groups and technological development cycles can be projected *ad infinitum*, and that it is difficult to determine where to stop in the application of a SCOT analysis.[12] The social constructivist argument has a tendency to work itself into a corner, as it contrives to force a sterilized and empirical methodological framework onto groups of living people. A possible social constructivist defense of this characterization would be to qualify this move as an attempt to impart the dynamism of the relevant social groups onto the kind of technological developments they describe, better equating the two and showing that technological artifacts are possessed of their own kind of energy and relevance.

This possible counter-argument echoes some of the tenets of Actor Network Theory (ANT), a concept conceived by Bruno Latour and Michel Callon. This concept is inappropriately named, as it is less a theory than it is a "travel guide" to the understanding of what Latour describes as the social web in which we and technological artifacts are enmeshed (Latour 2005, 17). Latour, a seminal figure of the new materialist movement, seeks to remove the dichotomy of the human and the non-human. Latour asserts, "ANT is not, I repeat is not, the establishment of some absurd 'symmetry between humans and non-humans.' To be symmetric, for us, simply means *not* to impose a priori some spurious *asymmetry* among human intentional action and a material world of causal relations" (76, emphasis his). It is not his intention to insist on equality, or symmetry, between the two ends of this spectrum, merely to eliminate the notion that there is a predetermined hierarchy between human agency and material (or in our case, technological) causality.

Latour proposes that all social relations are conducted by actants, all inextricably linked along social, cultural, and physical lines. Latour prefers the term "actant" to "actor" as the latter term carries an unwelcome anthropocentric connotation. Peter-Paul Verbeek's example of such a relationship is a car, as a car on its own is nothing more than a technical conglomerate that has no relative meaning without its accompanying networks of roads, gas stations, drivers, and mechanics (Verbeek 149). The mobile device is perhaps a more ready example of ANT in action, as it in particular is incapable of functioning without both the wireless network that connects it to others and the semiotic methods it uses to convey meaning.

Steve Matthewman points out the linkage between ANT and Foucault, as "ANT shares Foucault's definition of power as the ability to affect the actions of others" (116). This, also, is true particularly in terms of mobile devices and social networking. In *Discipline and Punish* Foucault famously analyzed the panopticon, a type of prison designed by Jeremy Bentham (200). In this kind of building, prisoners are housed in concentric rings, with the doors of their constantly-lit cells facing inwards. In the center of the cylindrical building is a guard tower, whose occupants are concealed. The overall effect is one of constant monitoring, where one guard could effectively keep watch on multiple cells simultaneously. While perhaps not physically possible for one person to monitor hundreds of cells wrapped all around them, the fact that the prisoners cannot see the guard, or what direction they face, means that they suffer under the constant supposition of being monitored.

Panopticism, in many respects, perfectly describes the semiotic network created by mobile devices. GPS-enabled devices allow the potential of tracking someone's movements in their own house. This particular aspect has already permeated the culture consciousness to the point that it is a cliché for police procedural dramas. The specter of hackers accessing the camera or microphone on a device casts an Orwellian shadow. The well-publicized hacks of multiple celebrities' phones led to the proliferation of personal and intimate photos, exposing those victims to the cruel panoptic eye of a culture ever more enmeshed in the pervasively invasive nature of the mobile device.

Material and semiotic connections are just as important to a consideration of ANT as the idea that anything can be viewed as an actant, as long as that thing creates or assists in the creation of meaning. This kind of relationship has led ANT to sometimes be referred to as a "material-semiotic approach," as does Matthewman in his book *Technology and Social Theory* (112). A key distinction between SCOT and ANT is that ANT, according to Matthewman, "generally believes that studies should only be undertaken in the present, when science and technology are in the making, while the controversies are still raging" (107). ANT, with its emphasis on social connections between entities (with no distinctions drawn between subject and object), takes an important step away from the constructivist group-oriented view point and centers more firmly on individuals within the network.

Despite the ontological and practical issues with imposing the SCOT framework on a particular artifact, I still cannot deny its usefulness in aiding my understanding of the snarled and labyrinthine processes that must take place for the development of any kind of technology. When we apply this model to the cell phone, we can see not only the technological advances that led to our current state, but also the pronounced change these advances have made on the way humans interact with their environment. We can see an amplification of Freud's worry about his distant loved ones, as an increase in connectivity has an inverse effect on the anxiety produced by the lack of connectivity. A constructivist breakdown of the history of the cell phone points to patterns of interaction with these artifacts. The initial constraint of relevant social groups, limited in this case to the crews of naval vessels, gives way to larger and larger groups. Technological refinements, from the batteries that power them to the signals they tap in to, push these devices further and further to the forefront of social life. As affordability and ease of access increase, a correspondingly larger mark is left on the fabric of society, changing the way people interact with other people and with objects. People wanted smaller and smaller cell phones, and the manufacturers obliged by innovating and then cramming smaller and more efficient batteries, receivers, and speakers into their devices. With the advent of mobile internet access, the trends changed tack, and suddenly larger screens and enhanced graphics were demanded to improve the mobile media consumption experience. Each step in the process that led to the mobile device in my pocket can be charted as a series of relationships between users and problems.

A greater focus on our interaction with technology is required to overcome the bureaucratic restrictions of social constructivism. For mobile devices in particular, the user experience is more prized to developers than anything else, but the user experience only reflects the most superficial interactions with technology. When Langdon Winner criticized the SCOT framework for addressing only the material effects of technology and sidestepping mention of the cultural effects and those to "…the sense of self," he pointed to a blind spot in that framework. While SCOT was never intended as an all-encompassing theoretical model of technology, it is still an easy, if fallacious, step to take to equate the desires of relevant social groups with those of the individuals within that group. A constructivist reading of the cell phone shows us how it came to be, and where it came from, overcoming obstacles in portability and functionality to become an almost omnipresent piece of technology. What is now required to develop a deeper reading of this artifact is the theoretical context that will allow for a more nuanced discussion of technology's place in the social sphere, and how those forces shape its development.

Chapter III
The Technical Genome

Moving away from the case studies and empiricism of the constructivist viewpoint requires deliberation on the less quantifiable aspects of technological development and subject-object interactions. The mobile device's place in the lifestyles of many has been fundamentally altered by the vast range of services and content we can now access with them. Mobile data allows almost every corner of the internet to be explored just with a tapping thumb. But how has the mobile device evolved from the cell phone? How did users come to demand functions that far surpass the cell phone's intended design? A SCOT analysis will not satisfactorily answer this question, so we must look to technogenesis.

The idea of technogenesis grew out of the writings of Bernard Stiegler, in the first volume of his book *Technics and Time*. Stiegler conducts a close reading of Bertrand Gille's *Histoires des Tecniques,* André Leroi-Gourhan's *Milieu and Techniques*, as well as Gilbert Simondon's *Du mod d'existence des objets techniques*, in which he posits that technology (or, as Stiegler phrases them, technics) and humanity each influence the development of the other. Additionally, there is the idea that we have enjoyed a technogenerative relationship for far longer than one might anticipate, and that we should only anticipate an acceleration of this phenomenon.[13] While discussing Gille, Stiegler focuses on technological evolution as a matter of large technical systems, which are defined as interconnected series of commercial and non-commercial entities who rely on each other for materials.

An example of a technical system in flux would be the automotive industry. For decades, the predominance of the gasoline engine, in everything from weed whackers to ocean-roving cargo ships, has resulted in oil producers (both commercial and state-owned) being some of the wealthiest entities on the planet. For many years, gasoline prices hit higher and higher limits, prompting a resurgence of research into commercially viable hybrid or electric cars. Vehicles like the Toyota Prius, Nissan Leaf, and Tesla Model S are now regular sights on American highways. Electric vehicles of many descriptions have been around since the late nineteenth century, although their decline in popularity (until recently) is largely attributed to the improvements of national highways and the 1913 rollout of the Ford Model T.

For Gille, the cycle of technical innovation is a function of macroeconomics, a systemic establishment, adjustment, and re-establishment of the status quo. Stiegler sums up this concept by saying that "…the development of consumerism, accompanying constant innovation, aims at a greater flexibility in consumer attitudes, which adapt and must adapt ever more quickly…" (32). There are limits to this kind of system expansion, as Gille explains. The technical system of any era contains a limited set of foci upon which the technical paradigm subsists.

For computing in general and mobile devices in particular, Moore's Law plays a massive role in defining boundaries. This law --- really the extrapolation of an article written by Gordon Moore --- describes how the architecture of the integrated circuit will decrease in size about every eighteen months (Moore 1965). The size of the integrated circuit, as well as the heat they generated, were fundamental barriers to technological progress. Moore predicted that continual development in this area would yield faster computers at an exponential rate. The mutability of the technical system can also be seen in Moore's law, where the integrated circuit leads to a faster establishment of the microprocessor as a balance point within the current technical system.

While Gille and Stiegler speak in terms of a single focus, I cannot see a way around allowing for multiple balance points. If we are to consider the myriad processes and robust infrastructure that enables mobile device usage, we have to consider the crucial elements of the system (or, as Kevin Kelly calls it, the technium): the power grid that enables the devices and services to function, the battery that enables the mobile device to work with only an ethereal link to the grid, and the antennae, both internal and external to the device, that permit communication. When we expand our view to the overarching system within which nearly every extant human calls home, we arrive at three points of equilibrium:

1) Fossil fuels
2) The microprocessor
3) The internet

Without these three crucial elements, daily life in most countries would not resemble what it does today. Without CPUs and the internet, the flow of data is slowed, almost stopped. Without fossil fuels, massive sections of the planet would be without electricity, rendering the second two options moot. These three balance points support our current technical system, but it has not, and will not always be so. The internet and CPU are relatively new players to this game, but have become so integral to daily life that we must consider them to hold this status. Our perception of this system is enframed by its limitations, which Gille describes as being both economically focused and dependent on other sectors of industry. As discussed in the previous section, Marconi's creation of the mobile telegraph is an event that foretold a shifting of equilibrium of his era's technical system. The device crashed into the technical limitations of his day (the overall size of the device, the power supply, the limited frequency range, and so forth), but challenged them and initiated their expansion.[1] While the transition took decades, the idea of wireless communication exhibited the right balance of potential and infeasibility to trigger the shift, and play a significant part in the system to follow. It is important to include mentions of potentiality and difficulty in realization as those are the logical key drivers of surpassing limitations. When Stiegler writes that technological innovation takes steps towards those limitations, that they are "…inscribed in the real while transforming it, thereby respecting its laws," he discusses the same incremental accretion of traits and functions that mirrors biological evolution (34).

The methodology behind the transition from one technical system to another is of massive importance in understanding the developmental path of the mobile device. Through his reading of Gille, Stiegler points to the idea that technics, and technical systems, grow and are shaped by the same forces that affect populations in ways that are human-driven, but not always human-controlled. The vast technical complex that permeates nearly every aspect of life has evolved in such a way that one of its countless derivatives is the mobile device. For Gille, any emergence of technology out of a technical system is the result of both human enterprise and the sprawling evolutionary tendencies of that system. Our look into the history of the mobile device certainly corroborates this. The devices we carry in our pockets today are so unlike their forbears, namely Marconi's telegraph and Ericcsson's car-borne telephone, that one might struggle to even begin comparing them. The modern mobile device, though, is as much a progeny of those early contraptions as a Maserati is to a horse and buggy.

Taking a different angle on the same subject, André Leroi-Gourhan notes that in distinct and separate ethnic groups, technological development occurs in roughly the same order. Leroi-Gourhan suggests a model of facts and tendencies to explain this phenomenon, with technical facts being specific to the geo-social orientation of any given group, and technical tendencies being an archetypal progression pattern. Interestingly, his background as an anthropologist allows Leroi-Gourhan to discuss incidences of technical innovation from the distant past, often focusing on pre-historic groupings and types of technologies.

As a further caveat, this is not intended as an ethnocentric reading, and what is perhaps most remarkable about Leroi-Gourhan is his resistance to any such readings. It is at once cold-bloodedly rational and highly progressive of Leroi-Gourhan to take this approach, writing as he did in the mid-1940's. Stiegler notes his emphasis on this, and it's worth quoting in full:

> There is no 'genius of peoples' at the origin on the [technical] phenomenon: there are facts that, inserting themselves into ethnic milieus, take on their concrete aspects as technical objects; but there emergence always results from a more profound determinism, beyond ethnic characteristics, which alone can account for the clear-cut cases of universal technical tendencies." (48)

Leroi-Gourhan thinks of technology as tendency. Disparate ethnic groups will act on these tendencies and transmute them into technical artifacts. Making these tendencies concrete happens in patterns across cultures and continents, and this is evidence of a sort of technical universality. It is important to note that while the *tendency* is universal, the concretized form of the tendency is not—one example provided is of body piercings from Brazilian, African, and Inuit tribes, which are all related in function, but differed in their design and in their cultural currency (Stiegler 47). These three culture's lip rings are technical facts, the realized artifacts, as expressed through the technical tendency.

Fabricating and using tools do have some measurable effect on human physiology, as well. Stanley Ambrose, in his 2001 article "Paleolithic Technology and Human Evolution," describes the relationship between using tools and changes in the section of the brain that processes speech. For a member of one of the above civilizations, the mere act of grasping a stone axe, or the donning of ceremonial beads, is the beginning of a crucial co-evolutionary process.

But what are we to think of cultures that developed in close proximity to each other? The concession Leroi-Gourhan makes to this eventuality is that the technical facts expressed are still distinct, but more similar. His example of this is a plow developed by Malaysian, Tibetan, and Japanese cultures. These three cultures had varying degrees of communication in their ancient history, but however similar these plows were in function, they varied greatly in their overall design, as well as in their cultural significance and currency. The sense of the universality of the technical tendency is preserved, regardless of their relation to, or borrowing from, other groups. Borrowing technical facts, in this model, does not preclude the idea of that *tendency* already having been expressed: "…the only transmittable traits through borrowing are those that mark an improvement of procedures. A less flexible language, a less developed religion can be borrowed, but the cart cannot be traded for the hoe" (Stiegler 54). It is difficult to consider all the possible challenges to this kind of developmental model. In one way, it dovetails nicely with the idea of technogenesis as a whole, and seems a logical starting point for Gille's discussion on the technogenerative properties of much larger technical systems. In another way, it seems unfeasible and unwieldy to think in terms of universalities. Leroi-Gourhan also struggles with the idea of modern levels of manufacturing and communication. He makes an attempt to address this by describing mega-ethnicities, or a much larger, planet-spanning group. Stiegler, in his analysis, wonders if this heralds the dissolution of ethnicity (in regards to technical tendencies) or if it will instead result in the reaffirmation of smaller, more variegated groups.

In the current age it is clear that the idea of the mega-ethnicity has won out, but is more clearly expressed as a technical system, *qua* Gille. What is presented is certainly intriguing, and it need not be universal to be a worthy point of contention. The fact that the overall trend towards technical tendencies exists is more than adequate to support the idea that technogenesis is and has been a powerfully determinative influence on humanity. It is significant that Leroi-Gourhan focuses on pre-historic cultures, as it gives us a better view of the technic as evolving alongside the anthropogenic. The technogenerative forces that slowly improved the axe, the knife, and the plow (which are all outgrowths of the same concept) through the concretization of technical tendencies are the same that have resulted in the mobile device.

The concept that human and technological development has become closely intertwined, to the point where there is an undeniable mutual influence, is of profound importance. Applying these ideas to mobile devices requires some complication of the ideas of Stiegler, Gille, and Leroi-Gourhan. The tendency for cell phones up until the early years of the new millennium was towards smaller and thinner products. Visual timelines of different cell phones models reflect this initial tendency: the massive Motorola DynaTAC 8000X was 10 inches long and weighed a hefty 2.5 pounds, with an 8 hour battery charge allowing for approximately 30 minutes of talk time ("Looking Back on 40 Years of the Cell Phone"). Subsequent models slimmed down the device itself while enhancing the technical aspects such as battery life and internal memory. Any visual timeline of cell phones will show a consistent reduction in size from model to model, with one of the smallest and thinnest models available being the 2004 Motorola Razr V3 flip phone, which boasted a 3.86 inch, 3.42 oz body with 400 minutes of talk time on the battery (phonescoop.com). Up to this point, the cell phone continued the technical pattern of shrinking in size while growing in functionality, as is common with electronic products. Only a small number of functions, mostly calls, were expected of these devices, and once the technology to perform those functions was perfected, engineers could begin streamline the devices to make them easier to hold, more portable, and work better.

This exemplifies a more traditional model of technological development, such as SCOT. The increasing availability of affordable mobile data plans in the early 2000s led to the realization that cell phones didn't just have to be for communications –-- they could allow users to consume media in ways that had previously not met with much success. The ability to play music and video files, access the internet, and allow for application usage were not unique to cell phones, but these activities found their broadest audience there. The turn towards media consumption in cell phones prompted new designs –-- larger screens that responded to touch reclaimed real estate once required for physical buttons and fostered a higher resolution viewing experience. A phone's internal memory was now not only being sourced to save frequently dialed numbers, but to run operating systems. People started to care more and more about the processing power and graphics display qualities of their phones. According to Taylor Martin, this increased interest started around 2004, when manufacturers changed their target demographic from enterprise users to everyday consumers ("The Evolution of the Smart Phone"). Batteries had to become more and more efficient in order to meet the growing power demands of graphics-intensive applications.

The effect of technogenesis is easily spotted. As the demand for phones that could also function as media portals increased, the standard developmental paradigm went out the window. Instead of making smaller and more streamlined cell phones, they became bigger and bigger to accommodate larger, sharper displays. The change in design philosophy is intrinsically linked with shifts in the user's perception of the product. Simultaneously, more and more media consumption options became available simply due to the capabilities of the new devices ("The Evolution of the Smart Phone"). This kind of accretive developmental pattern is more in keeping with Gille's idea of the progression of large technical systems, as it is a constant challenging of limitations and gradual normalization of new limits. We can still apply Leroi-Gourhan here, but it would be more useful to shift his discussion of ethnic groups to socio-economic groups. This reconsideration becomes a necessity in the face of the technological development cycle's capitalistic impetus. Where Leroi-Gourhan wrote of the technology of pre-historic, pre-currency tribes, to consider the mobile device economics must be accounted for.

It has long been the standard for technologies that the first marketable iterations of devices are poorly designed or buggy, or inordinately expensive. For instance, I clearly remember buying my first DVD player in 2002. I saved up $200 from my summer job and purchased the bulky demo model of a clearance unit. It barely fit on my shelf, and dwarfed my thirteen-inch television. If I had waited a few years, I would have been able to pick up a smaller, more reliable model for around $40. A similar trend can be seen across all technological sectors, but it is particularly profound for mobile devices. The previously mentioned Motorola DynaTAC 8000x cost a staggering $3,995 when it was released in 1984 (Wolpin). This made it exclusively a plaything of the rich. Couple the high price with the relative lack of network availability and sparse features (such as the one hour of talk time on a full charge) and you get a bulky, revolutionary, prohibitively priced status symbol that was destined for ubiquity. Those with the financial resources to afford not only the phone but the network plan to go along with it comprise the first socio-economic "ethnic" group to resolve this tendency into technical fact. By a combinatory process of technological diffusion and market research, cheaper models with better features began appearing. Within 20 years, phones would be on the market for a tenth of the price, with features (such as mobile internet browsing) that could not be easily comprehended in 1984 ("The Shrinking Price of Mobile"). These technical facts gradually become available to all socio-economic groups, to the extent that today it seems more common to encounter someone who chooses not to have a mobile device than someone who can't afford one.

The reason for this phenomenon is simple, but still expresses the idea of the technical tendency. When new technology is developed, the production costs are much higher, which in turn get passed on to the consumer. Better designs, cheaper parts, and standardized manufacturing processes all contribute to the gradual decline in price. If we interpret the technical tendency as a function of economy, rather than one of ethnicity, we are better able to elide the principles of diffusion and concretization found in Leroi-Gourhan with our current state as a globe-spanning technological system.

Another way to think about this cyclical development comes from Gilbert Simondon's "technical ensemble" idea, conveyed in his book *Du mode d'existence des objets techniques* and scrutinized by Stiegler and by N. Katherine Hayles in her book *How We Think: Digital Media and Contemporary Technogenesis*. Simondon views technologies as composed of three distinct types: technical elements, technical individuals, and technical ensembles. The technical element is an individual piece that usually helps form a larger or more complex artifact. A technical element for a mobile device could be the screen, the battery, or the plastic shell that contains the electronics. Taken separately, they are all still technological artifacts, but incomplete without the presence of other artifacts. When the screen, battery, case, and electronics are assembled and functioning, we get a technical individual. The technical ensemble flows from the individual, and "gestures toward the larger social/technical processes through which fabrication comes about" (Hayes 87). Hayle's example for this continuity is a stone axe, a relatively simple artifact, but the technical ensemble is still markedly more complex than the tool itself. Everything from the flint and hide used to knap the axe's head, the animal that was killed to provide the leather straps, and the wood used to form the handle are all components of the technical individual.

The leap to technical ensemble comes when consideration of the processes by which all of these components are derived. Who knapped the flint, and how, and how did they know how to do so? Who tanned the hide? Who honed the handle? Questions of material, process, and transmission of knowledge all shape the final artifact, indelibly linking it to the social sphere in which it was created. As a product of this social sphere, Simondon allows virtually no room for individual contribution, relegating them largely to the role of user, rather than originator.

This example is of an intimate process—the painstaking crafting of an artifact by an artisan. Mass production problematizes this idea. If widgets are being churned out through an assembly line, do they still count as technical ensembles? Does the wide-scale proliferation of technology degrade the linkage between the artifact and the social web that dreamed it up and created it? Writing many years after Walter Benjamin's "The Work of Art in the Age of Mechanical Reproduction," it seems inconceivable that Simondon would omit consideration of this. Benjamin writes of the mass reproduction of art and its effect on authenticity, or aura. Benjamin defines aura as the ritualistic meaning assigned to art, which originated in ancient religious idols. He argues that technological innovation performs the opposing tasks of destroying the unquantifiable elements that make art special while simultaneously liberating it from its highly ritualistic trappings (220). For Benjamin, mass production is a bow wave presaging the dissolution of authenticity, or, as Benjamin writes, "…that which withers in the age of mechanical reproduction is the aura of the work of art" (219).

Alex Goody, however, finds a pro-technology aspect to Benjamin's argument. In her discussion of Benjamin and the works of William Carlos Williams, she finds a liberating property in William's machine-like composition, prompting her to say:

> And the use of technology enables a connection, a refusal of artistic aloofness and an erasure of the aura of the fetishized 'voice,' that brings his work closer to the positive technological effects that Benjamin identifies [...]. This points to the empowering facet of Benjamin's theories, offering an art that is released from elitism by the power of technology, a democratizing force in culture and one that makes the quotidian, as revealed through mechanical devices, its worthy subject. (26)

Concern over authenticity also enters into the writings of Peter-Paul Verbeek in his criticism of the German existentialist Karl Jaspers. In Verbeek's *What Things Do*, he points out Jasper's fear of the dissolving or diffused self as a tragic side effect of the mass production. Like Benjamin, Jaspers wrote in the 1930's, an era where mass production through mechanization was imminent but not yet ubiquitous. Jaspers worried that the idea of human workers relegated to operators and maintainers of the true instruments of production would distance them from themselves, resulting in a "mass existence" that subsumed individuality. In a more contemporary lens, logic-driven software automation evokes the same worries, a George Jetson scenario where the human function in a technological process can be seen as largely a token extension of responsibility. Jaspers, amusingly, inadvertently foreshadows this somewhat spurious comparison by writing that life in his era "…could not exist to-day but for the titanic interlocking wheelwork of which each worker is one of the cogs" (Jaspers 39). Alienation, for Jaspers, is ultimately due not to the changing nature of production, but to the suppression of an authentic life (Verbeek 45).

Verbeek criticizes Jaspers on his notion that the human maintains sovereignty over technology by pointing to the prominent effects of technogenesis: “Technologies coshape the human world and thus also human relations within technology itself. Human beings are not sovereign with respect to technology, but are, rather, inextricably interwoven with it” (45). The question of the authentic, whether applied to an artifact or to the human using the artifact, holds less importance than initially feared by Freud, Benjamin, Ellul, and Jaspers. We remain a generative force, capable of dynamic growth and innovation, but we do it not in opposition to the indefatigable forces of machinery or software, but in concert with them.

What remains germane is the question of disruptions to the social and cultural webs that produce and use technological artifacts, and whether the advent of the mass proliferation of mobile devices complicates Simondon’s concept of the technological ensemble. The application of the “axe crafter” concept to mobile devices requires some adjustment of scale. The myriad developments and advances that coalesced into what we now call a mobile device are convoluted and staggered, much more so than the relatively simple creation of a stone axe. To properly define the mobile device as a technical ensemble, we need to expand its provenance to include the market research, corporate approvals, investors, engineers, manufacturers, and suppliers of raw material as much as we must include the technician who assembled the device. This is the path to concretization for this technical ensemble, a process that results in the physical artifact and is an expression of the sometimes contradictory abstractions required for its realization.

For Simondon, the more concretized an artifact, or the more efficient the inclusion of the abstract ideas that then embodies the technical ensemble, the more advanced. Hayles provides an excellent example of this, in the form of a modern steel axe head (88). Her choice of this example is astute, as its similarity and marked improvements over the stone axe example demonstrates both the technical tendency and the enhanced concretization that denotes a more refined technical ensemble. The modern steel axe head must be forged and tempered in such a way that it possesses both the material strength to hew wood without breaking and still allows the handle to absorb the impact. The degree of concretization demonstrated in this artifact is the result of it incorporating two conflicting abstract solutions in one ensemble.

Mobile devices are communication, distraction, knowledge, and memory distilled to pocket size. Their degree of concretization is evidenced by their inclusion of all these traits and more. For Simondon, these elements are all part of the dynamic framework that houses both anthropological realization and, as Stiegler puts it, "the *process of concretization* by functional overdeterminism" (Stiegler 68, emphasis his). Essentially, the advent of mass production, of automated manufacturing processes, has relegated the human to an operator's role.

We also cannot deny the secondary effects of the mutually-supportive instantiations of the technical tendency and the technical ensemble. The explosive growth of mobile devices has fostered similar amounts of growth and investment in the technical infrastructure that supports them. The tablet market does not owe its birth to the mobile device, but its continued survival is due to those devices borrowing wholesale many of its functions. The graphical user interface (GUI) of the Windows operating system is trending towards a more tablet-friendly aesthetic, a move which owes much to the simplified interfaces required, due to screen size restrictions, on mobile devices. Applications for Android and iOS devices have turned into multi-billion dollar revenue streams for their respective owners.[14] This is the ripple effect of technogenesis. The mutually evolutionary relationship between humans and technology, in creating massively consumed artifacts like mobile devices, has simultaneously created myriad ancillary artifacts, required for their support and continual development.

The wheels of the machine keep rolling, with humanity as a passenger, because there is a form of intrinsic ordering present in them. Machines are the results of human agency, ones that have been crafted so well that they bear our imprint, our DNA, and as such possess their own peculiar form of agency.

Anyone who has worked to automate large-scale data-retrieval processes will tell you that machine logic is unflinching,and unyielding. In *The Power of Myth*, Joseph Campbell described his computer as "…an Old Testament god with lots of rules and no mercy" (1988). Writing a piece of software is like world creation: you have certain parameters that limit you, but the laws you inscribe will function exactly as you set them, whether or not their end result is what you intended. This rigidity of form, while solely dependent on inputs, is not always so dependent on *human* inputs. In carrying out its function, a machine, or a piece of code, ingests its instructions, executes its function, and creates something new. Regardless of who or what instructed the technology to perform that function, the newness (if not the uniqueness) of the end result is unquestionable. We cannot deny some semblance of agency to a line of code that writes another line of code, or writes a record to a table. We should not restrict the development of any technology, including mobile devices, to an engineer's lab or the clinical environs of an assembly facility. Increasingly sophisticated software, the internal processes of which are usually called logic, allows for increasingly more complex automated, or intelligence driven, functions.

Of particular interest in this vein are self-healing wireless networks.[15] The software controlling wireless nodes maintains a proximal sense of other nodes in the area, and their relative signal strength. If a node dips in strength, other nodes in the region adjust their strength accordingly to maintain coverage, and also work to isolate the network disturbance until the affected node can recover. All of these processes happen within their designer's parameters, but happen without human input or interference. The machines, the processes we set in motion can make decisions and meaning on their own, taking for their own some small sliver of the adaptive nature that we anthropocentrically call our own.

I argue that the concept of a technical ensemble can survive outside the confines of the artisan fabricator, such as Simondon's axe crafter. Expanding and complicating the process of artifact creation and communication of knowledge does not degrade the efforts involved in its creation. The increasingly convoluted nature of technical ensembles instead gestures to the exponential complexity of our relationship with technology. The axe crafter is creating an artifact of necessity –-- without the axe they cannot defend themself or prepare skins and wood for shelter. The design and function of the axe is based upon the crafter's skill in making such an object, its intended use, and the materials available. The axe crafter has no concept of technology that does not affect their immediate material needs or enable their survival.

On the opposite end of the spectrum are the self-propagating, self-correcting wireless networks that facilitate an unprecedented volume of communication. These massive forms of technology routinely operate without human intervention, as they are designed. The fundamental differences between these two technological scenarios both still demonstrate the technogenerative relationship between humans and technology. The axe crafter improves himself, and the wireless nodes function in an almost Marxist fashion by showing that the integrity of the network as a whole is more important than any individual contributor.[16] We can see similar developments in the interactions between people and their mobile devices. Part of its unique qualities is that many would be quick to claim a mobile device as an absolute necessity. While this level of relationship will be discussed in detail later on, it does touch on the ubiquity of this particular artifact.

In his book *What Technology Wants*, Kevin Kelly remarks on the mobile devices startlingly rapid rise to ubiquity. He relates this anecdote:

> I remember an early-adopter techie friend who bought one of the first cell phones for $2,000; he carried it around in its own dedicated briefcase. I was incredulous that anyone would pay that much for something that seemed more toy than tool. It seemed equally ludicrous at that time to expect that within two decades, the $2,000 devices would be so cheap as to be disposable, so tiny as to fit in a shirt pocket, and so ubiquitous that even the street sweepers of India would have one. (305)

As a further comment on the mobile device's explosion into the cultural consciousness, Kelly shares the fact that in two decades, 90% of Americans either own or use a cell phone, and that for electricity to reach this level of diffusion, it took over seventy years (Kelly 299). What this staggering figure shows us is that we are rapidly assimilating the mobile device into our social fabric. Our desire for omnipresence and distraction has birthed a rapacious cult of connectivity.

We can turn back to Kelly for some description of how this frenzied cycle began. One of the key terms of his book *What Technology Wants* is exotropy, a word borrowed (and re-spelled) from Max More (63). Exotropy, a synonym for negentropy, is the opposite of entropy, the tendency of all matter to use less energy than is available and so, through a gradual string of inefficient energy usage, decline into disorder.

Handy examples of entropy, recalling the earlier discussion on bicycle development, are bicycle brakes. If I was riding a bicycle down a hill that I suddenly deemed too steep for my liking, I would apply the brakes to slow myself down. Standard bicycle brakes work by squeezing the brake lever on the handlebars. The lever applies tautness to a control cable, which runs down the frame of the bicycle to the brake caliper, which straddles the wheel. When the control cable tightens, the calipers apply pressure to the rim of the wheel, which is gripped by brake pads. The friction from the pads then slows down the wheel, eventually bringing me to a stop. From an energy usage viewpoint, this system is functional but inefficient. Of all the available energy supplied by the control cable, some of it is invariably lost through heat, and so not all is used to stop the bike. This lost energy is entropy. Expanding the idea of entropy out over a massive scale is a way that physicists explain the tendency for matter and systems of matter to shift from an ordered state to a more chaotic one.

Conversely, exotropy, as Kelly describes it, is the natural tendency towards efficiency, diversity, and homeostasis. The path taken by an electrical charge is an exotropic expression, as it will follow the easiest, most efficient route from its source to its destination. Part of Kelly's argument is that exotropy more closely aligns the evolution of the technological with that of the biological, as biological evolutionary trends tend towards the same advantages. These trends, or tendencies, are partially listed as "…diversity, sentience, opportunity, mutuality, ubiquity…" (Kelly 271). Essentially, life will tend to evolve on an exotropic basis because that basis will result in a more stable organism or system that is more capable of survival.

There is much of value in this analysis, but we can problematize it. Kelly's vision of exotropic progression as a reflection of biological evolution includes the idea of random mutation, but pays lip service to it. He builds a triangular pattern of evolution that allows for change on the grounds of three points: the inevitable, the contingent, and the adaptive (Kelly 182). The inevitable mirrors what *must* happen, according to physical laws and limitations. The contingent is how historical events and patterns have led to the current circumstances in an evolutionary cycle, and the adaptive represents the forces of natural selection and unpredictability. This succinct expression of evolutionary mechanisms does not do justice to the extraordinarily convoluted paths that evolution can take.

Earlier in *What Technology Wants*, Kelly describes the journey of a single hydrogen atom across an unfathomable amount of time, detailing how the atom occasionally bumps into other matter, and by complete happenstance lands on a planet to be just one atom among many trillions. Biological evolution takes a similarly chance-ridden (though on a far shorter time scale) journey to arrive, or not arrive, at a viable organism. Kelly's view is oriented on the idea that the exotropic evolution of an organism will only result in that organism being better and more able to survive, when the reverse of that statement is also most certainly true. Jerry Coyne even argues that Kelly overlooks the vast swath of single-celled organisms that have not, over the millennia, evolved commensurate with Kelly's triad (2010). Biological evolution is such an immensely complicated and difficult-to-prove processes that I will not continue trying to argue for or against Kelly's assertions, as I simply do not have the background. I am not convinced that his biological triad accounts for the totality of the evolutionary process. I do find great value in Kelly's description of technological evolution, which is much more clearly a teleological process and more readily adaptable to my idea that this process mirrors social and psychological movements and dependencies.

While Kelly's triangular evolutionary model may not be the most appropriate for biological evolution, there is much to be said about this same model when applied to technological evolution. The adaptive path is converted to the intentional, meant to illustrate the agencies, real and quasi-, present in the evolution of the technium. The technium, as Kelly defines it, is the totality of the technological world, including not just gadgets and machinery but also concepts, innovation, and "the generative impulses of our inventions to encourage more tool making, more technology invention, and more self-enhancing connections" (12). The evolutionary path followed by the technium is one cultivated by a staggering number of influences, everything from market research and global weather patterns, to dinner choices or buying a pair of headphones because they're on sale. The way Kelly envisions the technium, no movement, no choice, no matter how large or small, is discounted as a contribution to its progress.

The evolution of the technium mirrors the idea of technogenesis in that both theories hold that humanity and technology share similar evolutionary patterns, and that the evolution of one influences the evolution of the other. If we compare the technium to Gille's technical system, we can see commonalities between them. Both systems eschew focusing solely on the technological, and place great emphasis on the social, cultural, and economic forces that help drive them. Kelly's triadic developmental model closely matches Gille's idea of technical expansion, as both prescribe limits to the evolutionary path, establish a sense of historicity upon which new developments are contingent, and allow for expansion or refocusing as allowed by economic and human choice. This third point of the triangle is where they particularly agree, as both grant little credit to the actions of individuals in driving the technical system. As Stiegler describes it, "the logic of invention is not that of the inventor. One must speak of a techno-logic, of a logic literally driving technics itself" (36). Kelly, in his turn, writes that the "intentional domain consists of the many decisions individuals make about whether (and how) they use or avoid certain inventions" (183). In removing the individual from the equation, even the inventive genius of Leonardo da Vinci or Nikola Tesla play, in the eyes of the technium, only a bit part.

Technogenesis is a phenomenon that has existed since early man first used tools, as Leroi-Gourhan's technical tendency has illustrated. The idea that humans and the technologies they create have co-evolved is fundamental to our understanding of how we relate to each other and to the material world. Through reading Gille, we see how technological growth comes from the challenging of borders, and how Simondon and Stiegler reduce the scale of Gille's massive technical system. Kevin Kelly takes the technical system, consolidates it into one dynamic, global technium, and uses it as the basis for his technogenerative triad. Establishing technogenesis, by any moniker, into a coherent force that is at once grounded in the real and indicative of progression, shows how we interact with and are influenced by the material realm.

Chapter IV
The Blue Screen of Mediation

Our growing reliance on mobile devices is a step away from the measured approach suggested by Heidegger, and it is the technological utopian's corrupted vision. A cultural mindset of consumer capitalism is what spurs the development of these devices, without much in the way of nobility of purpose to distract us. The desire for connectivity and distraction has overridden worries of immediate survival, and the mobile device provides an outlet for this desire. What the axe crafter might not be able to comprehend is that our mobile devices have started fulfilling many of our social needs, and that this attribute, rather than their use in securing the basic elements of life, underscores their importance. The mobile device has become so deeply embedded into the cultural consciousness that it is difficult to perceive it as a mere piece of technology. The enhanced functionality and connectivity of the mobile device has had a pronounced effect on our relationship with them, adding a complicated facet to the subject-object relationship. For this section, the focus will be more on our relationship with technology and mobile devices on a more individual level, and of how the mutual technogenerative relationship is still present, but requires viewing from another angle.

We can turn back to Heidegger, for he in particular expresses concerns about our relationship with technology. As previously discussed, Heidegger's essays "The Question Concerning Technology" and "The Memorial Address" underline a fundamental anxiety about technology in the age of mechanization and automation: how can we accept technology as a method to improve resource availability and the quality of life, but not become machine-like ourselves?

When Heidegger, along with Jaspers and Ellul, discusses the existential fear of humanity becoming either subservient to or wholly replaced by the machine, they are referring to the mechanization of the factory worker. Ellul in particular described the bleak scenario of a worker spending their day operating machines at work, only to come home and unwind by operating a different set of machines, succumbing to the "…techniques of relaxation," or the technological distractions largely embodied today by mobile devices (Ellul 128). The dilemma posed by Heidegger in "The Question Concerning Technology" has a posited resolution in his follow up work "The Memorial Address." Here, Heidegger states that a "releasement" is necessary for humanity to co-exist with the technological without allowing self-alienation. Heidegger's idea of releasement culminates in this statement:

> We can use technical devices, and yet with proper use also keep ourselves so free of them, that we may let go of them any time. We can use technical devices as they ought to be used, and also let them alone as something which does not affect our inner and real core. We can affirm the unavoidable use of technical devices, and also deny them the right to dominate us, and so to warp, confuse, and lay waste our nature….We let technical devices enter our daily life, and at the same time leave them outside, that is, let them alone, as things with are nothing absolute but remain dependent upon something higher. (54)

Releasement is a way of accepting the benefits afforded by technology but allowing for separation between the technological and the human. This separation allows us to maintain a meaningful relationship with technology, one where we reap its benefits, and still allows us to comprehend both its utility and its pitfalls. Heidegger's visions surprisingly border on the utopian, an era where humans can work and function alongside technology, but are not dictated by it, and can define its place in their lives ("leave it outside.")

The idea of releasement as a solution to the overreliance on technology makes sense when viewed within Heidegger's own historical context. If Heidegger were alive today to see the trajectory that technology has taken, how telegraphs and radios have coalesced into an omnipresent, globe-spanning meld of information, communication, and monitoring, his somewhat reluctant optimism might have been tempered. The ways in which we now relate to technology---and in particular, to mobile devices---are at a level of involvement and intimacy that Heidegger most likely could not have predicted. The traditional subject-object relationship, the "yawning gap" that Latour so assiduously seeks to bridge, has already been eroded by the mobile device (Latour 1991, 55).

Heidegger's technological trap has proven difficult to avoid. Since the introduction of the iPhone in 2007, which set the mold for the current iteration of mobile devices, there has been a growing tendency to become absorbed in them.

A humorous example of this comes from the city of Augsburg, and is detailed in an article of *The Guardian* by Janek Schmidt. The article shares the brief etymology of the word "smombie," a German portmanteau that literally means "smartphone zombie" (Schmidt 2016). It easily evokes an image that is by now all too familiar: someone walking along absorbed in texting or reading or gaming, who is oblivious to the world outside the tiny rectangular confines of their screen. In response to several smombie-related accidents, Augsburg has started embedding small traffic lights in the ground, with the idea of catching the attention of those whose sightline is reduced to the bare few feet in front of them. Whether or not the lights cause a decrease in accidents is yet to be determined, but it is perhaps an unprecedented acknowledgement of both the dangers of smombieism and the level of ubiquity now enjoyed by the mobile device.

Robert Earl, writing in *The Atlantic*, approaches this issue with far less levity. Earl describes what he terms a common scenario is American public high schools, where at every opportunity students haul out their phones to send a message or browse the web. He mentions several authors as defending the presence of mobile devices in the classroom, such as increased collaboration, audio recording, and participating in interactive polls and quizzes. Earl takes a contrasting stance, asserting that the presence of mobile devices in the classroom is a terminal distraction that lessens attention spans and robs the students of training in critical thinking, or even of doing simple arithmetic without a calculator. Perhaps unwittingly, Schmidt and Earl are pointing directly to the semi-dystopian anxieties of Heidegger and Ellul. These two real-world examples tend to show that humanity is not at all holding pursuing releasement, and are fulfilling Ellul's fear of a race enraptured by machinery. These two articles stand in contrast to the wary optimism of releasement, and complicate the subject-object dichotomy.

For much of this discussion, we have focused on large-scale concerns, of populations and percentages. Sherry Turkle, in her book *Alone Together*, humanizes the concept of subject-object relationships and problematizes them still further. Her depictions of interactions with various technologies, among them mobile devices, are the results of exhaustive research into the behavioral patterns between people are their gadgets. Turkle provides invaluable insight on an individual basis, presenting interviews and case studies of both groups and individual subjects. She analyzes the results of almost fifteen years' worth of surveys and interviews in which her subjects reveal the extent of their fondness for or ambivalence towards the plethora of technologies designed to interact with individuals, with the finding that there is a worrying trend towards social alienation due to increased subject-object intimacy.

One of the interviews Turkle describes is of a young lawyer who was just informed via a mass email that his younger sister is engaged. He is agitated by the fact that his sister did not call him to tell him news of this importance. He laments the impersonal nature of the delivery. However, Turkle notes that her subject “is never without his Blackberry. He holds it in his hands during our entire conversation. Once, he puts it in his pocket. A few moments later, it comes out, fingered like a talisman” (16). Turkle’s ironic portrayal of a brother irked by the lack of interpersonal connection with his sister while still needing to assure himself of his constant accessibility to others is one of many examples she provides of a deeply personal and convoluted relationship with mobile devices.

The fact that Turkle’s subject is worrying his Blackberry is at once indicative of the time at which the interview was conducted and of mobile data’s powerful influence. By allowing for almost constant connectivity, we can see here some evidence that technology has molded our perceptions to anticipate that connection, and to react negatively to its deprivation. In some cases, the reaction can be physical. The common “affliction” or neurological phenomenon known as “phantom vibration syndrome” is a physiological manifestation of the anxiety caused by constant connectivity. It’s a common enough scenario: the user has their device in their pocket, and feels a vibration in their leg. Whenever they check their device, there are no messages or notification. Phantom vibration syndrome is something that, according to a study cited by Larry D. Rosen in his book *iDisorder*, up to two-thirds of mobile device users have experienced (55). Constant connectivity via the mobile device has so altered our perceptions that we are creating physical responses tailored to their anticipation. This phenomenon is most likely not what Leroi-Gourhan had in mind when he described how the mere act of grasping a tool was an evolutionary step.

For Turkle, the need to remain constantly connected arises largely from our desire to prescribe the limits of emotional distance between us and others. The young lawyer is upset that his sister, whom he has recently visited, did not convey news of life-changing events to him in a more personal way, but still feels the need to remain constantly available to acquaintances and coworkers via his mobile device. His behavior shows that we have started using mobile devices as social filters; relatives and close friends can communicate with him in person, but those outside that exclusive social sphere must have their communications filtered through his Blackberry. Turkle's subject is at the deterministic crossroads of the subject-object relationship, caught somewhere between desiring and despairing the technological mediation of his life.

To further her argument of mediation as a force that transforms senses of self and of reality, Turkle describes a group of MIT student in 1996 who called themselves cyborgs (151). Their aim was to study how increased connectivity affected their memory and any potential efficiency gains in their daily life. The group members walked around with small computers, wireless receivers, and pocket keyboards, with displays placed over one eye. They strolled around campus, able to surf the internet, use remote desktops, and communicate digitally at any location on campus. At the conclusion of the study, Turkle interviewed one of the participants, who said that he felt lost without his mobile hookup. He told her, "'I feel invincible, sociable, better prepared. I am naked without it. With it, I'm a better person'" (152). Turkle remarks on the subject's level of connection with these bulky devices, writing, "…what had seemed alien was close to becoming everyone's way of life, as compact smartphones replaced the cyborgs' more elaborate accoutrements. This is the experience of living full-time on the Net, newly free in some way, newly yoked in others. We are all cyborgs now" (152).

The young man Turkle interviewed in this section clearly presaged the current state of interaction with and reliance upon mobile devices. If he, walking around a limited area with a bulky apparatus strapped to him, felt so transported, so altered by his new capabilities, one has to wonder what he would have thought at the idea that twenty years from his experience, almost everyone would be carrying small, powerful computers with constant connectivity. In contrast to Robert Earl's stance, this study participant would no doubt be extolling the virtues of the mobile device. By allowing us instant access to almost any piece of knowledge or connection with anyone on our contacts list, there is a strong case to be made that mobile devices evidence an era of both instant gratification and immediate learning.

Donna Haraway wrote extensively on the subject of cyborgs in her essay "A Cyborg Manifesto." For Haraway, the cyborg is a feminist metaphor—a rejection of inflexible boundaries in exchange for a melding of identity and politics. However, there is value in considering a more literal approach to her handling of the cyborg, with no desire or intention to detract from her powerful message of gender identity and politics.

Two of the distinctions she draws are those of the dichotomy of organism and machine, and of the boundary between the physical and the non-physical. Haraway asks the question, "Why should our bodies end at the skin, or include at best other beings encapsulated by skin?" (314) In a way, we have already taken steps towards answering this. Even if one does not have technology embedded in their body (such as a titanium hip joint or a mechanical heart valve), the omnipresence of the mobile device is enough for almost anyone to consider themselves a cyborg.

Its use in almost every aspect of life establishes it as near to a synthetic implant as can be attained without going under the knife.

Turkle's recounting of the MIT cyborgs flows from Haraway's analysis. Borders and limits, like with Gille's technical systems or Kelly's evolutionary triads, play a crucial role in Haraway's analysis. A cyborg cannot exist without the idea of contravening borders, of incursions and melds that span Latour's gap and joins the organic with the synthetic, the human with the technological. The mobile device is perhaps the easiest way to demonstrate that cyborgs are not merely creations of science fiction, but are us and are all around us.

In a sense, we can look all the way back to Lysias and Socrates in *Phaedrus* and see the same argument. If Lysias and Theuth's exuberance for the written word as an aid to memory and wisdom has turned out to be a truth, then surely the ubiquity of the mobile device can be seen as a similar truth. Wearable technology is taking this further still, as now fitness trackers and smart watches are succeeding where the Google glass has failed. Our cyborg nature has again spurred technological advancement, has again whet our desire for more constant technical interaction and mediation.

The identification and subversion of borders resulting from the omnipresence of the mobile device are just one way in which our relationship with this particular technical ensemble has come to mirror its developmental path. Like Simondon's axe crafter, we have a specific set of expectations for our technology, but the rate of technological advancement dictates the depth and complexity of those expectations.

Turkle provides other examples of this phenomenon, most notably a section on robots and toys. She presents and interviews groups of people with different kinds of computerized toys

(Furbies and a robotic dog called AIBO, for example). Her younger subjects have perhaps the most telling reactions. Turkle presents Furbies to a group of children, who first puzzle through what they are, and then try to decide if they are alive. The verdicts are mixed, and largely based on the Furbies' ability to make eye contact, speak, and react to the world around them (44). The children get distressed when the Furbies develop "diseases" like dead batteries. There is some consternation as to whether or not humans have batteries, or if animals have motors inside (37). Turkle's subjects begin conflating their own biologies with those they imagine inside the Furby, and in doing so show that this particular piece of technology, in its potential to mimic "aliveness," has blurred the boundaries between subject and object.[17] Some of the young subjects of this exercise develop meaningful relationships with these artifacts by experiencing the little traumas and triumphs programmed into their Furby.

What Turkle's research shows us is that the more lifelike and interactive a toy, the easier it is to invest emotionally in it. While she could have used a traditional stuffed toy and a separate group of children to provide a control study, her end goal was not to measure the time it took to develop an attachment, but how the lifelike characteristics of the toy facilitated that attachment. Because of this relationship, her subjects were able to project emotions and desires onto the toys. They found similarities between themselves and the Furbies. They related to them perhaps on a deeper level than even the imaginative license of play normally allows. By relating this study, Turkle points to an enhanced ability to develop a more intimate relationship with technology than that of a typical subject and object.

Shifting this concept to mobile devices must include this sense of play, since one of their main functions is to serve as a source of entertainment and distraction. The turn from a device solely devoted to wireless communication to one that is more suited for media consumption was a product of the reciprocal relationship between user and developer. With the advent of SMS messaging and wireless data plans, phones like the Sidekick grew in popularity. When users wanted more features packed into the same device, cameras, color screens, and faster wireless networks were the end result (Hahn). A small, flip-out screen and a full QWERTY-style keyboard reflected the desire for computer-like connections and conveniences while out and about. The devices, in essence, were a miniaturized laptop, and were initially branded "hip-tops" (Hahn). While exhibiting little of the design and stylistic departures that contemporary smart phones possess, the Sidekick was an important step in consolidating the functions of disparate devices, answering the consumer's desire for a phone that is more than a phone.

The ability to send SMS text messages and emails gave rise to devices like the Sidekick and the Blackberry, whose full keyboards allowed for faster typing. The ability of a Blackberry to connect to a corporate email server, paired with its robust security features, made it a fast favorite in the business community (Cardinal). Efficiency and streamlined communication were the buzzwords that fueled the Blackberry craze. When Apple audaciously introduced the iPhone, an outgrowth of their wildly successful iPod music player, there was no shortage of skepticism among the major players of the tech sector.[18] Other companies, like Compaq, Hewlett-Packard, and Sony, had been working on mobile computers before the iPhone stormed onto the scene. Apple had even dipped a few tentative toes into that market with the Apple Newton (Honan). The similarity with all these devices is that hardware, typically a stylus, was required to input data. Discussing the Apple Newton in particular, Mat Honan relates how Steve Jobs loathed the device and the idea of a stylus, quoting from Steve Job's autobiography, "'God gave us ten styluses,' he would say, waving his fingers. 'Let's not invent another'" (Honan). The move away from keyboards and styluses were what made the iPhone so revolutionary—all one needed to use the device was a finger. The touchscreen removed the mediator between user and device, dissolving the empty space between them. Doing so allows the user a more efficient means of interaction, and because of this a relationship can be formed between subject and object that is more than one of mere tactility.

Conclusion

Long thought of as an objective process of innovation and application, the advent of the mobile device is a turn towards the consideration that the developmental cycle is a symbiotic, organic developmental process. Through different philosophies of technology, we can derive an overall vision of the technogenerative process. Therefore, we must view the study of technological development through bifocals, as we must accept that both innovation and experience play powerful roles in this process. Freud and Heidegger gestured to sources of mistrust and anxiety in technology by showing that there is a chance that a technological innovation will create as many problems as it resolves. Ellul and Jaspers grounded the discussion by providing the more traditionalist mindset of technology, where only the human creates or influences, and has ultimate domination over his handiworks.

Moving from the stage set by these two, the methodological framework created by Bijker and Pinch allowed us to trace these anxieties and problems through the social development of the mobile device. Bruno Latour opened the discussion to non-human actants and gestured to the human/object dichotomy as an impediment to understanding the social webs that bind the world together. Through Stiegler's analyses of Gille, Leroi-Gourhan, and Simondon, as well as the analyses of Hayles and Kelly, the agency and function of these artifacts and actants were more fully explored. Sherry Turkle and Donna Haraway then fostered a discussion of human interactions with technology, their place in the technium/current technical system, and how these elements mix with the human in ways that are increasingly personal and organic.

The design changes that resulted from consumer demand helped define the future of mobile devices. Removing the need for a physical keyboard and stylus, both of which were derided because of their clunky interface (except for a cult following of Blackberry users that still exist), and consolidating functions into one device created a better product that was better able to satisfy consumer demand. The ability to include some of the functions and conveniences of a desktop computer led consumers to want them all. Just as the ability to text led to QWERTY keyboards, so too did the rise of streaming video and mobile gaming lead to bigger, sharper displays and high performance hardware. The increasing desire to stay always connected, always distracted, has shifted the mobile device from luxury to utility. Tracing the provenance of these devices and examining their increasingly intimate and mediatory aspects allows us to shift theory to praxis. We can take the various theories on technology and combine them with case studies and data. Using elements from Bijker and Pinch, who both lamented what they saw as the inadequacies of technology theory, and Turkle's case studies, we can make some reconciliation of the age-old split between the theoretical and the practical. Conducting this sort of analysis on mobile devices reveals that they both stem from and predict a culture where our desires are projected back upon us through the lens of technology.

Bibliography

Agar, Jon. *Constant Touch: A Global History of the Mobile Phone*. London: Icon, 2013.

Ambrose, Stanley H. “Paleolithic Technology and Human Evolution.” *Science*. Vol. 291, No. 5509, 2001, pp. 1748-1753.

Bellamy, Edward. *Looking Backward 2000-1887*. New York: Grosset & Dunlap, 1887.

Benjamin,Walter. “The Work of Art in the Age of Mechanical Reproduction.” *Illuminations* Ed. H. Arendt. Trans. Harry Zohn. Cape, 1970. pp. 219-226.

Biggs’s General Railway Acts: A Collection of the Public General Acts for the Regulation of Railways. London: Waterlow and Sons, 1898.

Borgobello, Bridget. “Looking Back on 40 Years of the Cell Phone.” *New Atlas*. http://newatlas.com/mobile-pnone-40-year-anniversary-photos/25677/

Campbell, Joseph and Bill Moyers. “The Message of Myth.” *The Power of Myth*, Ep. 2. PBS, 1988.

Cardinal, David. “How the Smartphone Changed Everything, or, the Rise of BYOD in the Workplace.” *Ars Technica*, 1/23/2016. http://arstechnica.com/information-technology/2016/01/how-the-smartphone-changed-everything-or-the-rise-of-byod-in-the-workplace/

“Chartbook of Social Inequality.” *Russell Sage Foundation*. http://www.russellsage.org/research/chartbook/welcome-page-description-detailed

"Computing and the Manhattan Project." *Atomic Heritage*. http://atomicheritage.org/history/computing-and-manhattan-project.

Coyne, Jerry A. “Better All The Time.” *The New York Times Sunday Book Review*. 11/5/2010.

Devinne, Paul. *The Day of Prosperity: A Vision of the Century to Come*. New York: G.W

Dillingham Company, 1902.

Earl, Robert. "Do Cell Phones Belong in the Classroom?" *The Atlantic*. 5/18/2012. http://www.theatlantic.com/national/archive/2012/05/do-cell-phones-belong-in-the-classroom/257325/

Ellul, Jacques. *The Technological Society*. Trans. John Wilkinson. New York: Vintage Books. 1964.

Elmer-DeWitt, Philip. "How Much Revenue Did iTunes Generate for Apple Last Quarter?" *Fortune*. 7/21/2013 http://fortune.com/2013/07/21/how-much-revenue-did-itunes-generate-for-apple-last-quarter/

"ENIAC: Celebrating Penn Engineering History." *Penn Engineering.* http://www.seas.upenn.edu/about-seas/eniac/operation.php.

Foucault, Michel. *Discipline and Punish: The Birth of the Prison*. Trans. Alan Sheridan. New York: Vintage Books, 1995.

Freud, Sigmund. *Civilization and Its Discontents*. Trans. Joan Riviere. Ed. James Strachey. London: Hogarth Press, 1930.

Frothingham, Thomas G. *A True Account of the Battle of Jutland May 31, 1916*. Cambridge, MA: Bacon & Brown, 1920.

Gille, Bertrand, ed.. *The History of Techniques.* Vol. 1: *Tehcniques and Civilizations;* Vol.2: *Techniques and Sciences*. New York: Gordon and Breach Science Publishers, 1986

Goody, Alex. *Technology, Literature, and Culture*. Malden, MA: Polity Press, 2011.

Hahn, Jason Duane. "The History of the Sidekick: The Coolest Smartphone of All Time." *Complex*, 9/11/2015. http://www.complex.com/pop-culture/2015/09/history-of-the-sidekick

Hamilton, Ray. *The Joy of Cycling*. West Sussex, UK: Summersdale Publishers, 2013.

Handford, Peter. "Lord Campbell and the Fatal Accidents Act." *The Law Quarterly Review* 420 (2013). pp. 1-28.

Haraway, Donna. "A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century." *The Cybercultures Reader* Eds. David Bell and Barbara M. Kennedy. New York: Routledge, 2000.

Harrington, Ralph. "The Railway Accidents: Train, Trauma, and Technological Crisis in Nineteenth-Century Britain." *University of York Institute of Railway Studies and Transport History.* N.P., 2003

Hayles, Katherine. *How We Think: Digital Media and Contemporary Technogenesis*. Chicago: University of Chicago Press, 2012.

Heidegger, Martin. "Memorial Address." From *Discourse on Thinking: A Translation of* Gelassenheit by and trans. John M. Anderson and E. Hans Freund. New York: Harper and Row, 1966.

-----, "The Question Concerning Technology." *Basic Writings*, ed. David Farrell Krell. Trans. Max Niemeyer Verlag. San Francisco: Harper, 1993.

Hills, Jill. *The Struggle for Control of Global Communication: The Formative Century*. Urbana, IL: U of Illinois P, 2002.

Honan, Matt. "Remembering the Apple Newton's Prophetic Failure and Lasting Impact." *Wired*, 8/5/2013. https://www.wired.com/2013/08/remembering-the-apple-newtons-prophetic-failure-and-lasting-ideals/

Jaspers, Karl. *Man in the Modern Age*. Trans. Eden and Cedar Paul. New York: Routledge, 2010.

Kelly, Kevin. *What Technology Wants*. New York: Viking, 2010.

Khoo, Michael. “Technologies Aren’t What They Used to Be: Problematising Closure and Relevant Social Groups.” *Social Epistemology* 19, Nos. 2-3 April-September 2005, pp. 283-285.

Klemens, Guy. *The Cellphone: The History and Technology of the Gadget that Changed the World.* London: McFarland and Co., 2010.

Latour, Bruno. *Reassembling the Social: An Introduction to Actor-Network Theory*. Oxford: Oxford UP, 2005.

----. *We Have Never Been Modern*. Translated by Catherine Porter. Cambridge, MA: Harvard University Press, 1991.

Leroi-Gourhan, André. *Milieu Et Techniques*. Paris: Albin Michel, 1945.

Martin, Taylor. “The Evolution of the Smart Phone.” *Pocketnow*. 7/28/2014. http://pocketnow.com/2014/07/28/the-evolution-of-the-smartphone

Madrigal, Alexis C. “The 1947 Paper That First Described a Cell-Phone Network.” *The Atlantic*, 9/16/2011. http://www.theatlantic.com/technology/archive/2011/09/the-1947-paper-that-first-described-a-cell-phone-network/245222/

Massie, Robert K. *Castles of Steel: Britain, Germany, and the Winning of the Great War at Sea*. New York: Random House, 2003.

Matthewman, Steve. *Technology and Social Theory*. New York: Palgrave Macmillan, 2011.

Moffett, Cleveland. “Marconi’s Wireless Telegraph – Telegraphing Without Wires Across the English Channel.” McClure’s Magazine, June 1899. pp 99-111.

“Motorola RAZR V3.” *Phone Scoop.* http://www.phonescoop.com/phones/phone.php?p=547

Pels, Dick. "The Politics of Symmetry." *Social Studies of Science* 26, no. 2 (1996): 277-304.

Petrovan, Bogdan. “How Does Google Make Money From Android?” *Android Authority*.

1/22/2016. http://www.androidauthority.com/how-does-google-make-money-from-android-669008/

Plato. *Phaedras. Plato on Rhetoric and Language*. Trans. Alexander Nehamas and Paul Woodruff. New York: Routledge, 2008.

Rosen, Larry D. *iDisorder*. New York: St. Martin's Press, 2012.

Schmidt, Janek. "Always Practise Safe Text: The German Traffic Light for Smartphone Zombies." *The Guardian*. 4/29/2016. https://www.theguardian.com/cities/2016/apr/29/always-practise-safe-text-the-german-traffic-light-for-smartphone-zombies

Segal, Howard. *Technological Utopianism in American Culture*. Syracuse, NY: Syracuse University Press, 2005.

Siler, Wes. "Spock and the Motorola StarTac." *Gizmodo*, 2015. http://gizmodo.com/spock-and-the-motorola-startac-1688496340

Simondon, Gilbert. *Being and Technology*. Ediburgh: Edinburgh University Press, 2012.

Sterling, Christopher H. *Military Communiations: From Ancient Time to the 21st Century*. Ed. Christopher H. Sterling. Santa Barbara, CA: ABC Clio, 2008.

Stiegler, Bernard. *Technics and Time, 1: The Fault of Epimetheus*. Translated by George Collins Richard Beardsworth. 3 vols. Vol. 1, Stanford, CA: Stanford University Press, 1994.

"The Shrinking Cost of Mobile." Infographic. *Savings.com*. 12/20/2011.

http://www.savings.com/blog/post/infographic-the-shrinking-cost-of-mobile.html

"Timeline of Computer History." *Computer History*. http://www.computerhistory.org/timeline/computers/.

Trevor J. Pinch, Wiebe E. Bijker. "The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other.". In *The Social Construction of Technological Systems*, edited by Thomas P. Hughes Wiebe E. Bijker, Trevor Pinch, 11-44. Cambridge, MA: Massachusetts Institute of Technology, 2012.

Turkle, Sherry. *Alone Together: Why We Expect More from Technology and Less from Each Other*. New York: Basic Books, 2011.

Verbeek, Peter-Paul. *What Things Do: Philosophical Reflections on Technology, Agency, and Design*. Translated by Robert P. Crease. University Park, PA: The Pennsylvania State University Press, 2005.

Wendling, Amy E. *Karl Marx on Technology and Alienation*. New York: Palgrave Macmillian, 2009.

Winner, Langdon. "Upon Opening the Black Box and Finding It Empty: Social Constructivism and the Philosophy of Technology." *Science, Technology, and Human Values*. 18, no.3 (1993); 362-378.

Yenne, Bill. *Secret Gadgets and Strange Gizmos: High Tech (And Low-Tech) Innovations of the U.S. Military.* St. Paul, MN: Zenith Press, 2005.

[1] See Stiegler's *Technics in Time*, Kelly's *What Technology Wants,* and Hayles's *How We Think*.
[2] See Peter Handford's "Lord Campbell and the Fatal Accidents Act" *The Quarterly Law Review* (2013) 129.
[3] See *Bigg's General Railway Acts*, pp. 569.
[4] We also shouldn't dismiss the effects cultural artifacts have on technology. The Motorola StarTac phone so closely resembled the classic Star Trek communicator that Leonard Nimoy even acknowledge his ironic possession of one. See Wes Siler's "Spock and the Motorola StarTac" on *Wired*.

[5] Bernard Stiegler takes this idea to mean that technology as *Gestell* cannot be "defined as the means" and "carries the question beyond this anthropological level." (24) Here Stiegler can be read as anticipating the inclusion of non-humans into social networks.
[6] This famous paradox illustrates that no matter how many times the distance between two points is halved, the two points will never occupy the same place. This parallels the collapse of the technological utopia, as the "next great invention to solve everything forever" seems to perpetually loom just over the horizon.
[7] This essay comes out of a presentation given at a small, informal conference in Paris in 1983. Other attendees of this conference included Bruno Latour, Michel Callon, and John Law.
[8] In *The Joy of Cycling*, Ray Hamilton mentions that the poor braking capabilities of the Penny Farthing lead to it being nicknamed "the widow maker" (40)
[9] The diagram on page 31 of Bijker and Pinch's article illustrates these advances as some of the solutions to the various problems encountered by the distinct groups of users.
[10] This was a 1916 naval battle between English and German fleets that ended in chaos and controversy. A numerically superior British fleet was held off by a smaller, slower German fleet largely by virtue of better tactics at night fighting. Most relevant to my discussion is that the Germans, now with shipboard radios of their own, were able to intercept and jam British radio transmissions, which sowed confusion among the British fleet and allowed the German forces to sink 14 British ships and escape. Both sides declared victory. See Robert K. Massie's *Castles of Steel* and Thomas Goddard Frothingham's *A True Account of the Battle of Jutland*.
[11] Additionally, Marconi once posited a wirelessly controlled ship using his technology. He also hinted that this technology would be useful for controlling torpedo or suicide watercraft in battle. Cleveland Moffett, McClure's Magazine, June, 1899, pages 99-112
[12] See Pels, "The Politics of Symmetry" and Khoo, "Technologies Aren't What They Used To Be: Problematising Closure and Relevant Social Groups."
[13] The translator's choice to translate the French *technique* as technic is in adherence to the original etymology of the word, which derived from the Greek *tékhnē*. The word is now nearly synonymous with the English "technique" but originally meant "art" or "craft."
[14] According to Bogdan Petrovan, in 2015 Google netted around $10 billion from app sales. On the iOS side, Philip Elmer-DeWitt states that iTunes generated $12.9 billion for Apple in 2012.
[15] Two prominent papers on this subject are "GS3: Scalable Self-Configuration and Self-Healing in Wireless Sensor Networks" by Hongwei Zhang and Anish Arora and "Self-Organizing, Self-Healing Wireless Networks" by Chip Elliott and Bob Heile.
[16] See Amy E. Wendling's *Karl Marx on Technology and Alienation*, 96.
[17] In particular, one of Turkle's eight year old subjects, after interacting with a Furby, declares that there is a screw in her belly button, and that both people and Furbys have batteries. The only difference is that human batteries "'work forever like the sun'" (37).
[18] Cardinal goes further to describe how Microsoft, in particular, disregarded the iPhone as a gimmicky device that would not gain much traction in the corporate sector, where Microsoft enjoyed a dominate market share.