12-1-2017

Awakening The Potential of Positive Computing: A Transversal, Heliotropic Design Paradigm for Human Flourishing

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Keywords
positive technology, positive computing, positive design, well-being technology, nurturant technologies, technology for well-being, technology for human flourishing, technology and well-being, technology and happiness, affective computing, social media and well-being, positive paradox, technology addiction, digital ethics, technology ethics

Disciplines
Business Law, Public Responsibility, and Ethics | Communication Technology and New Media | Digital Humanities | Mass Communication | Other Anthropology | Other Business | Other Communication | Other Psychology | Science and Technology Studies | Social and Cultural Anthropology | Social Media | Technology and Innovation | Theory and Philosophy

Awakening The Potential of Positive Computing:
A transversal, heliotropic design paradigm for human flourishing

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A Capstone Project Submitted

In Partial Fulfillment of the Requirements for the Degree of

Master of Applied Positive Psychology

Advisor: Dr. Judith Saltzberg-Levick

December, 1, 2017

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Introduction

This paper argues for a more profound understanding of Positive Computing. While maintaining the present optimism about computing technologies' potential to cultivate human flourishing, this work is a critical analysis of the emerging domain and related literature. This paper attempts to bring together and advance a number of related bodies of work spurred by a belief that positive science is capable of more; that Positive Computing is capable of more; that *we* are capable of imagining and designing more for ourselves. In this effort, I answer the call (Turkle, 2011; Greenfield, 2015) to deeply consider what technology may be doing *to us*, setting aside the enticing draw to make fresh demands on what it ought to do *for us*. Herein, I offer a revitalized positive psychology scholar-practitioner perspective on the matter. I propose that by understanding how technology is harming us—even while it simultaneously delivers aid—and by pursuing research that uncovers the inherent aspects of technologies that intrinsically cultivate well-being, we can expand our present understanding of the extent to which technology can be positively calibrated for individuals, institutions, and societies.

The work begins with a foundation of positive psychology, including its origins, major figures, and a comprehensive definition. I proceed by reviewing present approaches to the design of computing technologies, the innovations of constructive technology applications, and in turn, the current literature on positive computing and positive technology. I continue by identifying a positive paradox, whereby the same aspects of technology that facilitate constructive and positive outcomes are simultaneously capable of producing damaging effects, supported by a short review of research findings identifying the harm of computing technologies. In an effort to uncover the contextual basis for these deleterious effects, I provide explanations for the two predominant orientations toward technology and therein, review the influences of several technologies throughout history. Before resolving to a final section with considerations for the future, I review emergent theories explaining the evidence of harm, ranging from the earliest research on the effects of the Internet to the recent literature. In the final section on the potential of Positive Computing, I argue for Positive Computing to operate within a transversal, social constructionist paradigm and propose a requisite ‘integral awareness’ required to appropriately address technological harm, understand the intrinsic positive aspects of technology, and develop a new, positive model of design for Positive Computing. In closing, the work is summarized and I offer final thoughts on the importance of Positive Computing.

Positive Psychology

Despite the research into aspects of happiness and well-being, the 20th Century was dominated by a disease-based model of psychology that neglected much of the human experience and unnecessarily limited the scope of psychology (Pawelski, 2016a). Nonetheless, the pioneering work of humanistic psychologists like Abraham Maslow and Carl Rogers, along with the renaissance of interest in topics such as strength, hope, resilience, creativity, and growth, helped birth what today is known as Positive Psychology. Recognizing mainstream psychology had become almost completely concerned with curing mental illness, Martin Seligman and Mihaly Csikszentmihaly have been at the forefront of a group of scientists undertaking a renewed effort to investigate well-being and optimal human functioning (Pawelski, 2016a). The proceeding section will review some of the major contributions to the field of positive psychology.

Happiness and well-being have remained a central concern of the human experience throughout history (Pawelski, 2016a). Agreement about what constitutes well-being, however, has perennially been contested. Religions have offered systems of belief to understand, define, and cultivate the optimal human experience. Political movements from the Renaissance, the Enlightenment, to liberalism, communism, fascism, and democracy have in their ways attempted to provide answers to questions of well-being (Pawelski, 2016a). The earnest search concerning what defines happiness and well-being, what constitutes it, and how it's cultivated has been characterized by two primary perspectives: the *hedonic* view where happiness is the result of positive experiences, and the *eudaimonic* view where happiness involves a life-long pursuit of meaning (Ryan & Deci, 2001). These two perspectives have likewise influenced contemporary research into happiness and well-being and are both represented within positive psychology.

In the hedonic view, life's ultimate aim is the pursuit of pleasure. Happiness is considered a result of subjective positive experiences– like pleasure, comfort, and enjoyment (Kahneman, Diener, & Schwartz, 1999). The hedonic perspective is concerned with the way individuals emotionally and cognitively experience the quality of their lives. A predominant area of research within hedonic psychology is subjective well-being (SWB), which includes three components: the presence of positive affect, the absence of negative affect, and a cognitive evaluation of life satisfaction (Diener, 1984, 2000). Instruments such as the positive and negative affect scale (PANAS) and the satisfaction with life scale (SWLS) have been developed to assess the degree of satisfaction with life using self-report measures (Watson, Clark, & Tellegen, 1988; Diener, 1994). Evidence suggests that SWB is positively correlated with longevity and physiological health (Diener & Chan, 2011). A landmark study by Danner and colleagues (2001) found a direct relationship between positive emotions in early adulthood autobiographical writings and longevity 60 years later. Among the School Sisters of Notre Dame, nuns with higher perceived happiness died at a median age of 93.5 years, compared to nuns who considered themselves less happy who died at a median age of 86.6 years (Danner et al., 2001).

Barbara Fredrickson's (2001) *Broaden and Build* theory underscores the role of positive emotions in SWB. The Broaden and Build theory asserts that positive emotions broaden people's thought-action repertoires and build lasting psychological, cognitive, physical, and social resources over time. In one study, Frederickson conducted with her colleagues, the intervention group that participated in seven weeks of loving-kindness meditation to induce positive emotions reported greater positive emotions and lower depressive symptoms and gains in mindfulness, environmental mastery, positive relationships, life satisfaction, and reduced illness symptoms compared to the wait-list group (Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008). Fredrickson's work also suggests positive emotions are capable of undoing aftereffects of negative emotions (Fredrickson, Mancuso, Branigan, & Tugade, 2000) and restoring cardiovascular equilibrium, which may indicate health-promoting functions, such as the prevention of cardiovascular disease (Kok & Frederickson, 2010; Tugade, Fredrickson, & Barrett, 2004).

In contrast to the hedonic view, the eudaimonic perspective conceives happiness as realizing the fullness of the human experience through individual virtues and personal potential in pursuit of complex goals that hold meaning for the individual and society (Ryff & Singer, 2008). Aristotle observed his contemporaries almost unanimously agreed the aim of "the good life" or "end at which all actions aim," was well-being– or, *eudemonia* in Greek (1962, Lvii.8). This eudaimonic approach to 'the good life' is a developmental pursuit of the self. It involves cultivating individual happiness through interpersonal relationships by integrating personal and collective space (Gaggioli, Riva, Peters, & Calvo, 2017). It involves self-actualization based on innate psychological needs and an inherent tendency for growth, forming the foundations of self-motivation and integration of personality, which are the essential tenets of self-determination theory (SDT) (Deci & Ryan, 2000). According to SDT, three basic, intrinsic needs must be met to foster psychological growth and well-being: *autonomy*, the need to be causal and self-governing agents who act in harmony with their integrated self; *competence*, the need to experience effective behavior; and *relatedness*, the need to connect with other human beings and experience caring for others. As an account of intrinsic motivation, SDT ties the development of psychological well-being to intrinsically-motivated action taken up because of interest and enjoyment, not because of external rewards. Evidence suggests well-being is improved for individuals who place less importance on materialistic goals and values, while well-being decreases over time among those who place more importance on materialistic goals (Kasser et al., 2014).

Mihaly Csikszentmihalyi's (1990) landmark contribution to positive psychology is the concept of flow. Flow states occur when an individual is completely consumed or absorbed by an activity. The experience of flow provides a pathway to meaning through an activity's autotelic nature, where something is pursued for its own sake, and through enjoyment intrinsic to experiences where the subjective significance of an activity grows richer with continued engagement (Csikszentmihalyi, 1997). These types of experiences occur when performing an activity stretches but does not exceed an individual's ability. A flow state is characterized by five qualities: 1) intense and focused attention in the present moment, 2) intrinsically rewarding regardless of the outcome, 3) a sense of control, 4) the sense that time is passing slowly or more quickly than normal, and 5) a loss of self-consciousness (Nakamura & Csikszentmihalyi, 2002). The benefits of flow are cross-culturally stable and have been associated with a variety of contexts, including leisure, work, and family, provided activities are perceived as complex opportunities for action that fit with personal skill and accommodate the requisite level of skill (Csikszentmihalyi & Beattie, 1979).

In order for psychologists to speak about and productively research ‘the good life,’ a unified vernacular and shared approaches to the characterization of optimal development and strategies for measuring the efficacy of interventions were required (Peterson, 2006): “Without comparable concepts and measures, it was impossible to generalize across programs to identify active ingredients that could be deliberately embodied in further interventions” (p. 138). Character strengths have been called the basic building blocks of goodness and human flourishing and provide this common language that can be used to recognize goodness in the self and others (Park, Peterson, & Seligman, 2004). Prior to Park, Peterson, and Seligman’s (2004) classification of character strengths and virtues, the taxonomy of psychological deficits represented in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM), had no equivalent accounting for people’s positive traits. Character strengths and virtues are universal personality traits found to be morally valued across nations, cultures, and beliefs (Peterson & Seligman, 2004). These traits manifest in an individual’s thinking (cognition), feeling (affect), willing (volition), and action (behavior). 24 character strengths have been organized within 6 basic virtues—where character strengths define the virtues.

In contrast to talent, skill, or ability, character strengths reflect an individual’s innermost psychological processes that enables of self-fulfillment. When developed well, character strengths can guide the use of talent, skills, and abilities (Niemiec, 2013). An individual’s top strengths—those most essential to who a person is—are called signature strengths (usually the top 5 ranked strengths). Engaging and expressing signature strengths has been found to increase happiness and decrease depressive symptoms (Proyer, Gander, Wellenzohn, & Ruch, 2014), uniquely predict higher well-being (Young, Kashdan, & Macatee, 2014), cultivate more positive emotions (Lavy, Littman-Ovadia, & Bareli, 2014), and produce higher job satisfaction and engagement (Lavy, & Littman-Ovadia, 2016). Moreover, according to Niemiec (2013):

- Character is a constellation. That is, character is plural. People aren't just a list of strengths, but are better understood as a profile of strengths that interact and are interdependent.
- Character strengths are stable but can and do change. Strengths may shift or change as a result of life events, deliberate interventions or conscious lifestyle choices.
- Character strengths are contextual and expressed in degrees. Depending on the context, an individual may express one strength over another, or engage their strengths in different ways and to a greater or lesser extent based on the circumstances.
- A balanced expression of character strengths is critical. Strengths can be under or over-used. Optimal strength is the right combination of the right strength, expressed to the right degree, in the right situation.

The foregoing research has contributed to multidimensional models and theories of well-being (see also Ryff & Keyes, 1995; Frey & Stutzer, 2010; Forgeard, Jayawickreme, Kern, & Seligman, 2011), including Seligman's (2011) PERMA model. Taking into account hedonic and eudaimonic benefits and concluding that well-being emerges form a profile of factors, PERMA comprises five elements of human flourishing: *Positive emotions, engagement, relationships, meaning,* and *achievement.* The five aspects of PERMA represent pathways that cultivate well-being that people pursue for their own sake. In the model, *positive emotions* are hedonic feelings of happiness (e.g. feelings of joy, contentment, and hope); *Engagement* is the beneficial psychological connection to activities or organizations (e.g. feeling absorbed, interested, and engaged in life); *Positive relationships* include feeling socially integrated, cared for and supported by others, and satisfied with one's social connections; *Meaning* refers to believing that one's life is valuable and feeling connected to something greater than oneself; and *Accomplishment* involves making progress toward goals, feeling capable to do daily activities, and having a sense of achievement (Kern, Waters, Adler, & White, 2015, p. 263). According to Seligman (2011), the five pillars of PERMA can be defined and measured independently, while also functioning of interrelationally.

Defining The Positive

The emergence of robust models of well-being notwithstanding, the burgeoning domain of positive psychology has nonetheless wrestled with a unified perspective on the most basic concept in positive psychology– the 'positive.' Pawelski's (2016a, 2016b) systematic examination of the *positive* helps organize and codify the work of scholars over the course of the last two decades. In this seminal work, Pawelski produces important advancement in the maturity of the domain of positive psychology, with a framework useful to this paper, both as a cogent description of positive psychology and as a means to guide the delimitation of positive technology. Pawelski (2016a) identifies five components of positive psychology that converge to produce a picture of the positive psychology domain: positive psychology's orientation, topography, context, process, and the ultimate aim of the field. Each is reviewed in turn.

Orientation. Seligman and Csikszentmihaly (2000) argued that "psychology is not just the study of pathology, weakness, damage; it is also the study of strength and virtue. Treatment is not just fixing what is broken; it is nurturing what is best. Psychology is not just a branch of medicine concerned with illness or health; it is much larger. It is about work, education, insight, love, growth, and play" (p. 7). In this way, they envisioned positive psychology's *orientation* as a necessary compliment to ‘business-as-usual’ psychology (Seligman & Csikszentmihalyi, 2000).

Topography. While the vigilant focus on the negative produced important advances in psychology following World War II—including the ability to effectively treat many of the known mental disorders—it came at a cost (Seligman, 2000). The cost was a model of mental health that was fundamentally disease-based. This disease model bred neglect of much of the human experience and unnecessarily limited the scope of psychology (Pawelski, 2016a). With the advent of positive psychology, a new *topography* was necessary. Instead of the preoccupation with repairing the worst parts of life, a new focus on building life’s positive qualities was required (Pawelski, 2016a). Topics like character, virtue, optimism, and hope now have cogent paths for application**.** Positive psychology encompasses both hedonic or subjective wellbeing components like positive affect, life satisfaction and happiness, and components of eudemonic wellbeing such as self-acceptance, positive relationships, autonomy, and purpose in life (Sin & Lyubomirsky, 2009).

Context. The science of positive psychology is concerned with pursuing the discovery and promotion of the factors that allow individuals, institutions, and communities to thrive (Seligman & Csikszentmihalyi, 2000; Sheldon, Frederickson, Rathunde, Czikszentmihalyi, & Haidt, 2000). The population positive psychology can help marks a *contextual* difference from mainstream psychology. Those receiving clinical care are not the only people who can benefit from psychological interventions. “If psychologists wish to improve the human condition, it is not enough to help those who suffer. The majority of ‘normal’ people also need examples and advice to a reach a richer and more fulfilling existence. (Seligman & Csikszentmihalyi, 2000, p. 10).

Process. With the scope of positive psychology concerned with building and supporting what makes life worth living (Pawelski, 2016a), scholars recognized the need for a shift in concern from what can go wrong with the human experience to the study of what causes individual flourishing and communities to thrive. To this end, where mainstream psychology was focused on healing and repairing damage, positive psychology is focused on the *processes* and mechanisms that build the positive qualities of an individual—areas of existing strength—and with what makes life worth living (Seligman, 1999).

Aim. Seligman (1999) believed positive psychology to be an integral part of the investigation and cultivation of the good life. In fact, he argued positive psychology was capable of articulating “a vision of the good life that is empirically sound and, at the same time, understandable and attractive. We can show the world what actions lead to well-being, to positive individuals, to flourishing communities, and to a just society (Seligman, 1999, p. 560). In Seligman’s view, positive psychology’s *ultimate aim* is, like Aristotle’s, the pursuit of the good life (Pawelski, 2016a).

Traditional psychology’s preoccupation with human psychoses—with fixing what is wrong with people—inadvertently mistook the absence of the negative as the same as the presence of positive qualities. After decades of study and empirical investigation, we recognize the positive and the negative are two independently identifiable dimensions (Pawelski, 2016a). The positive is not the same thing as the absence of the negative and well-being is not the same thing as the absence of ill-being (Sin & Lyubomirsky, 2009). Operations of the positive must be explicitly cultivated and built (Pawelski, 2016a).

The Intersection of Positive Psychology and Technology

Computing, Information, and Communications Technologies

Technology is arguably enmeshed with nearly every aspect of life in Western culture, with that pervasion continuing to increase. In the US, 95% of Americans own a cellphone of some kind (Anderson, 2015). 77% of Americans own a smartphone, which has grown from 35% when the PEW survey first began in 2011. Among smartphone owners in the US, 97% claim to send text messages, 89% use their phones to access the web, and 88% use their smartphones to send and receive email (Anderson, 2015). Among smartphone users, more than half of iPhone users can’t image their lives without their device and 40% of all smartphone owners said they would be anxious if they were separated from their phones for a day (Saad, 2015). An estimated 51.7% of the world population now uses the Internet (Miniwatts Marketing Group, 2017). Among the most connected continents, the percentage of Internet users jumps significantly: 88.1% of North Americans, 80.2% of Europeans, and 69.6% of Australians. Since 2000, worldwide Internet use has increased 976.4%. In that same time, use of the Internet in Africa alone has grown by 8503.1% (Miniwatts Marketing Group, 2017). Given the evidence for the expanding ubiquity of computing technology, its influence across industries, domains, and disciplines continue to grow along with it.

Defining Terms. Taken as a whole, *technology* or *technologies* are considered anything that extends or augments human ability or experience, from simple tools to complex machines. "Technology includes all tools, machines, utensils, weapons, instruments, housing, clothing, communicating and transporting devices and the skills by which we produce and use them" (Bain, 1937). Technologies are the means native human capacities are augmented or amplified. Technologies have been employed to extend human abilities and capacities in nearly every dimension of individual and social life. These augmentations and amplifications can be grossly divided into four categories (Carr, 2011):

1. Extensions of physical strength, dexterity, and resilience: e.g., the plow, darning needle, and the fighter jet.
2. Extensions of the senses: e.g., microscope, amplifier, Geiger counter.
3. Adaptations of nature: e.g., the reservoir, birth control, genetically modified plants.
4. Extensions of intellect: e.g., abacus, clock, map, book, and computer.

In contemporary society, "technology" colloquially refers to the specific field of *high technology* (hi-tech), including consumer product and enterprise computing industries and extends to the broad handling of the terms computing, computing technology, digital, and electronic communication. Herein, use of the terms technology, computing, computing technology, electronic communication, digital communication represent the broad spectrum of information and communication technologies (ICT), unless otherwise noted. This work represents ICT as the electronic devices and the experiences of their use characterized by the capability of both information processing and transfer to other devices via electronic connection protocol, such as the Internet or Bluetooth.

While computing technology can principally be considered an extension of human intellect, one reason ICTs are so dynamic is because they amplify and extend the technologies of other categories through the novel fusion with other tools and machines. Tractors and other farm implements can now be controlled remotely. What used to require a fighter jet can now be handled with a remotely operated drone. The clock has been incorporated into computing systems to synchronize automatic technologies of all kinds, where their operation is triggered without human intervention at all. Books are now read on digital devices, human biology (adaptations of nature) is now enmeshed with computing technologies in pacemakers and ingestible sensors contained in pills.

As the fusion of Internet connectivity and technological hardware devices has pervaded society, interest in the scientific study of technology has also grown. The scientific study of technology and its impact is known as cyberpsychology (Kwan & Bodford, 2015). The aim of cyberpsychology, which is also referred to as Internet psychology, digital psychology, and media psychology, is to understand the nature of human interaction with and through technology and the effects of ICT on social life and internal processes. Fields such as ergonomics, cybernetics, sociology, education, human-computer interaction, developmental psychology, industrial-organizational psychology, and marketing also undertake research on the influence of digital interactions (Kwan & Bodford, 2015).

Designing Information and Computing Technologies. The study and practice of people's interactions with ICTs is known as the field of Human-Computer Interaction (HCI)– where the "C" in HCI represents the range of ICTs. "Human-Computer Interaction can be defined as the discipline concerned with the design, evaluation, and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them" (Dix et al., 1992, p. 105). The prevailing paradigm of HCI was birthed from the computer science, business and information systems engineering (BISE), and management disciplines, where technology is deployed with the primary objective of improving efficiency and effectiveness of systems, tasks, and workflows and increasing the productivity of people (Pawlowski, Jansen, & Koch (2015).

What began as the domain of university research labs was eventually taken up for commercial business applications and eventually entered domestic consumer life, where the ubiquity of ICTs has continued to grow (Hinze-Hoare, 2007). As a result, individuals and society have received significant benefits. As technology applications reached beyond the bounds of the business context, the narrow, productivity-oriented perspective of the BISE paradigm began to give way to more humanistic approaches (Gaggioli et al., 2017; Pawlowski et al., 2015). Experience-centered design (Wright & McCarthy, 2010), user-centered design (Eshet, de Reuver, & Bouwman, 2017), values-sensitive design (Friedman, 1996), and human-centered design (Brown, 2009) approaches have introduced balancing perspectives to what has otherwise been a more singular focus on using technology to accomplish a task. As a result, attending to aspects of the human experience in user-interface interactions are a mainstream consideration in software development (Hassenzahl & Tractinsky, 2006). Today, the Internet is considered a ‘vital utility’ (Teske, 2002) and connected digital devices are essential parts of everyday life.

Humanistic approaches to technology development attempt to incorporate emotion, cognition, and behavior as design considerations given their relevance to the interpretation of and influence on technological environments. This has introduced further exploration into the gestures people use to navigate technology interfaces, how computing devices adapt to a user’s emotional state (a domain known as Affective Computing), interfaces that automatically adapt to user needs and preferences, and speech recognition where the voice is a user-interface (e.g., Siri, Amazon’s Alexa, Google Home) (Hinze-Hoare, 2007). Value-sensitive design brings attention to the personal views and values of technology designers that shape the systems and products. A techno-social lens is used to understand how the values chosen in the design approach (explicitly or not) influence issues like sustainability, privacy, and autonomy to support the final product

(Friedman, 1996). Values sensitivity is meant to keep the values of designers “in check” and ensure the value system selected as a part of the design strategy is in service to and aligned with those the solution is intended for.

Sensitivities to the way individuals experience technology applications and to the embedded values of a system introduced by humanistic approaches have added meaningful considerations to the design of technology products and systems. This has resulted in the increased adoption of technologies, made technologies easier to use, and supported the proliferation of technology into an increasing number of personal, business, and civic contexts (Kwan & Bodford, 2015). Even with the attention to the user experience the humanistic perspectives amplified within HCI (as the discipline concerned with the design of ICTs), the more human-centric design paradigm still functions primarily as a counter perspective to the business need and priority of technology enabled core task completion. Human-Computer Interaction remains principally concerned with the degree to which technology is usable. Usability refers to the degree to which a user is able to successfully engage with a technology application to benefit from its functional value. Moreover, HCI generally considers safety, utility, effectiveness, and efficiency as principle goals of ICTs (Hinze-Hoare, 2007).

Jacob Nielsen’s (1994) often cited list of usability heuristics were developed through a factor analysis of 249 usability problems to address and explain the majority of usability problems in ICT interfaces. A separate review of 28 HCI principles discussed in the literature produced a list of 8 most-cited rules governing the design of ICTs echoing themes similar to Nielsen’s (Hinze-Hoare, 2007). What these principles and heuristics demonstrate is an approach to designing ICTs through a deficit-focused prism. The approach assumes users will have challenges with the basic functions of use that need to be overcome. This perspective is not unfounded, however, and is necessary for the adoption of digital tools as synthetic extensions of human ability. The Technology Acceptance Model (TAM) and more recently, The Unified Theory of the Acceptance and Use of Technology (UTAUT) have extrapolated various factors that influence the use of technology (Venkatesh, Morris, Davis, & Davis, 2003). The UTAUT was developed through empirical analysis and testing, evaluating the theory of reasoned action, the technology acceptance model, the motivational model, the theory of planned behavior, a model combining the technology acceptance model and the theory of planned behavior, the model of PC utilization, the innovation diffusion theory, and the social cognitive theory as the basis for the work (Venkatesh, et al., 2003). The UTAUT identifies four main constructs in ITC acceptance and usage behavior: performance expectancy, effort expectancy, social influence, and facilitating conditions.

Considering the psychological factors that influence the adoption and use of technology, including the principles and heuristics that afford users safety, ease, efficiency, and enjoyment of use are important for the effective deployment and application of constructive ICTs. In turn, leveraging ICTs for *constructive* improvements to proficiency, efficiency and productivity has undeniable merit. The basis in a deficit paradigm, however, constrains the focus and intention of digital applications to certain degrees of utility that come with a set of evaluation criteria that is mostly a one-dimensional consideration for the success of a user’s task completion. If technology is to afford human beings more than conveniences, extended modes and mechanisms of communication, and boosts to productivity and efficiency, an alternate paradigm is almost certainly necessary.

Constructive Technology. To be sure, the paradigm of ICTs and HCI described above has afforded businesses, individuals, and societies *constructive* benefits from technologies. In addition to the Internet, digital innovation and computing technology has enabled the development and rapid expansion of innovations likes the checking account routing system, the 911 call system, the ultrasound, the magnetic resonance imaging (MRI), and high definition television (Carlson & Wilmot, 2006). The Internet itself has introduced unprecedented levels of connectivity between people and machines around the world. Today it is possible to communicate with someone nine time zones away instantaneously or asynchronously, via written text or via video message or conference. It is possible to control a device with another device remotely, like cameras, security systems, or light switches. Users can command technology with the sound of their voice and thermostats can learn the patterns and habits of its inhabitants to reduce waste and save money by making heating and cooling systems more efficient.

In some cases, *constructive technology* has produced observable positive outcomes– where well-being and human flourishing have been documented as outcomes. For example, using the Internet to communicate with close friends may improve well-being as measured by decreases in depression, loneliness and stress, and increases in perceived social support, mood, and life satisfaction (Rains & Young, 2009). In addition, the number of Facebook friends and positive self-presentation may enhance well-being (Kim & Lee, 2011). The same study suggests that honest self-presentation may enhance happiness provided by Facebook friends. Another study analyzed college students who joined Facebook Groups to get information about on and off-campus activities, socialize, seek self-status, and find entertainment. The study found students who joined Facebook Groups were more likely to participate in offline civic and political activities (Park, Kee, & Valenzuela, 2009).

While these positive outcomes are welcomed, they should be considered unintended side effects. It would be foolish to expect the current frameworks and deficit-based approaches to human-computer interaction to reliably produce anything but applications that increase productivity and efficiency and subsequently, meet those criteria for which they were designed. For technology to be leveraged for the express purpose of cultivating human flourishing, an alternate paradigm of technology design is required. This emergent perspective on the intersection of human well-being and digital technology is known as positive technology and positive computing (Peters & Calvo, 2014; Riva, Banos, & Botella, 2012).

Positive Computing and Positive Technology

Botella and colleagues (2012) define positive technology as "the scientific and applied approach for improving the quality of our personal experience with the goal of increasing wellness, and generating strengths and resilience in individuals, organizations, and society" (p. 78). To the extent technologies have been created to contribute to the enhancement of psychological well-being, only small number of applications can be included within the positive technology paradigm (Botella, et al., 2012). Riva and colleagues (2012), suggest three primary ways users' personal experience may be enhanced through technology:

- *Structuring personal experience* using a goal, rules, and the feedback system (e.g. serious games). The goal provides subjects with a sense of purpose focusing attention and orienting his/her participation in the experience. The rules, by removing or limiting the obvious ways of getting to the goal, push objects to see the experience in a different way. The feedback system tells players how close they are to achieving the goal and provides motivation to keep trying.
- By *augmenting personal experience* to achieve multimodal and mixed experiences. Technology allows multisensory experiences in which content and its interaction is

offered through more than one of the senses. It is even possible to use technology to overlay virtual objects onto real scenes.

- *Replacing personal experience* with a synthetic one. Using virtual reality, it is possible to simulate physical presence in a synthetic world that reacts to the action of the subject as if he/she was really there. Moreover, the replacement possibilities offered by technology even extend to the induction of an illusion of ownership over a virtual arm or a virtual body.

Further, Riva and colleagues (2012) offer three variables of personal experience that can be assessed and manipulated to guide the design of positive technologies, mirroring Seligman's (2002) three pillars of the good life: emotional quality (affect regulation), engagement/actualization (presence and flow), and connectedness (collective intent and networked flow). These three variables inform the authors' classification of positive technologies according to their effects on the features of personal experience:

Hedonic: Technologies designed to induce certain emotions, generally positive, and pleasant. Botella et al. (2009) developed a virtual reality (VR) mood device designed for aging populations called the Butler System. The intervention included a walk-through nature along with a series of Mood Induction Procedures (MIPs). The narrative encouraged users to enjoy a beautiful day in a lively or colorful field or in a peaceful and relaxing environment. After use, mood states of elderly users improved, with an increase in positive affect and a decrease in negative affect.

Eudaimonic: Technologies created to support engaging self-actualizing experiences. Riva and his colleagues (2012) developed a VR program called EARTH (Emotional Activities Related to Health) as a part of the MARS500 research project. The application is designed to help astronauts on a future mission to Mars by simulating a space trip and the psychological effects of a 520-day confinement with six people in tight quarters. While data are still being collected on the study, the MIPs features allow users to recall and enjoy their memories at any time.

Social/interpersonal: Technologies used to support and improve social integration and or connectedness between individuals, groups, and organizations. The PosiPost project was created to record and share positive emotions with other online (Kanis & Brinkman, 2008). Participants were prompted to complete the sentence, “Today I like “ to encourage positive postings that were shared with other users.

Calvo and Peters (2014) offer positive computing as a more universal philosophy on the design for well-being. Pawlowski et al., (2015) propose that "positive computing gives priority to a broader interpretation of the outcomes, such as a quality-of-life or well-being of users. Positive computing comprises concepts, processes and systems which contribute toward the quality of life and well-being of users” (p. 405). Sander (2011) suggests positive technology is “the study and development of information and communication technology that is consciously designed to support people’s psychological flourishing in a way that honors individuals’ and communities’ different ideas about the good life” (p. 311). Positive computing’s focus on the development of technology to support well-being and human is framed as a divergence from the typical focus in business, management disciplines, and information systems engineering to improve efficacy and effectiveness and efficiency from the perspective of an employer (Pawlowski et al., 2015; Calvo & Peters, 2014). To the extent Positive Computing is taken up as a strategy to the design of ICTs, Calvo and Peters (2014) identify four categories of strategic integration:

Dedicated integration: A technology that is purposefully built and dedicated to foster well-being and human potential in some way. This might include apps that cultivate gratitude and meditation, platforms that support behavior change through effective goal setting, and mental health applications that deliver therapeutic interventions.

Active integration: A technology (e.g., email, word processing, social networks) that supports components of well-being or human potential, but was not designed with well-being as its expressed intent. This category might include technologies that invoke empathy and gratitude using social networks or altruism in video games.

Preventative integration: Obstacles or compromises to well-being are treated as errors. These are the evident problems that attract cultural attention due to reports of technologies' influence on stress levels and compromises to memory and our children. This category might include attempts to ameliorate the technological harms that contribute to cyberbullying or concerns about shrinking attention spans.

No integration: Well-being and human potential were not considered in the design of the technology. Considered the present baseline by Calvo and Peters (2014), most software is created without consideration for human well-being and personal development. (Gaggioli, Riva, Peters, & Calvo, 2017, p. 478; Calvo & Peters, 2014, p. 89-91).

Information and communication technologies logically contribute to ways to achieve the goal of helping individuals and societies flourish (Pawlowski, Jansen, & Koch, 2015). ICT's can contribute to speed of delivery, monitoring, individualization, and reach and scale, which can make services more widely available). More discretely, BJ Fogg (2003) cites six advantages of computers relative to their ability compared to human capability and traditional media:

1. Computers can be more persistent than humans.

2. Computers offer greater anonymity.
3. Computers can manage huge volumes of data.
4. Computers leverage multiple modalities to influence.
5. Computers can scale easily.
6. Computers can go where humans cannot go or may not be welcome.

Fogg (2003) builds on these advantages and further suggests computers play three main functional roles. Computers function as a tool that helps users increase capability (e.g. making behaviors easier to do, leading people through a process, performing calculations and measurements). Computers can function as social actors creating a relationship with users (e.g. rewarding users with positive feedback, modeling a behavior or attitude, providing social support). Finally, computers can function as a medium that provides an experience for users (e.g. helping people explore cause-and-effect relationships, providing people with vicarious experiences, helping people rehearse behaviors).

Fogg’s (2003) functional triad provides support for the ways Sander (2011) proposes computers help users when negative events happen. According to Sander, computers can provide insight into negative events and patterns through monitoring abilities. They can alert users to the presence of stressful situations and in turn, make adequate coping resources available to them. When stressful situations may be foreseeable, computers may be able to prime users with appropriate resources. Finally, Sander (2011) hypothesizes that computers could also help users cope with challenging situations in real time.

For reasons I intend to make clear in this work, the term Positive Computing will be used from this point on and includes with it the meanings also represented in positive technology. In alignment with Calvo and Peters (2104), I contend that design for well-being ought to extend beyond psychological interventions and consider the entirety of technological systems and inform the design of all devices, software, and other extensions of human ability. Psychological well-being ought to be incorporated to the design of everyday things. In this way, “Positive computing aims to bring research findings from well-being psychology and neuroscience into the design of everyday technology interactions” (Gaggioli, Riva, Peters, & Calvo, 2017, p. 490).

The Positive Paradox

Does simply operating with an intention to facilitate human flourishing with computing technology deliver individuals and society a completely net upside? Evidence suggests otherwise. The serious consideration for technology’s potential harms appears to be a significant omission in positive technology and positive computing literature to date. The type of harm that’s been overlooked is the apparent deleterious effects of general use, not the intentional abuses and misuses. Explicit harms such as cyberbullying, child pornography, cyberstalking, cybercrime (phishing), and Cyberwarfare—to name a few—comprise a tragic set of harms that are discrete from those that stem from general constructive use. Evidence suggests it would be prudent to deeply consider the potential implications of the effects of technology on the self, the sense of self, biological functions, relationships, and the human experience of space and time (Teske, 2002).

Harm as byproduct. Smartphones have been blamed for many things—not the least of which is hijacking the mind (Carr, 2017). While dependent on the source and the definition of “use,” Americans certainly attend to their smartphones frequently. Research varies wildly on the number of times per day the average US adult interacts with their smartphone: 44 times (Deloitte, 2017), 80 times (Newcomb, 2016), 150 times (KPCB Trends, 2013), 2617 times (Winnick, 2016), and 5427 times (Winnick, 2016). While 91% of younger, Millennial Americans claim they have a healthy relationship with their technology, 53% of that same number wake up at least once each night to check their smartphone (Accel & Qualtrics, 2017). Such companionship comes with consequences (Clayton, Leshner, & Almond, 2015). When study participants were in the middle of a challenging task, just hearing a smartphone beep, ding, or buzz—even when the device's prompting was ignored—impaired reasoning and performance (Stothart, Mitchum, & Yehnert, 2015). Other research has shown ignoring the cues from mobile devices resulted in increased blood pressure and heart rate and degraded problem-solving ability (Clayton, Leshner, & Almond, 2015). In test performance, students whose phones were in view and within reach during testing scored the worst marks. Test-takers whose phones were in another room did best, followed by the students whose phones were in their pockets or backpacks (Ward, Duke, Greezy, & Bos, 2017). A follow-up experiment found the more heavily students used their phones in daily life, the more severely their performance suffered in the test-taking experiment.

This research suggests attachment to smartphones may be so intense its influence may extend beyond its use– that its mere presence leaves intelligence and attention diminished (Ward, Duke, Greezy, & Bos, 2017). The test-takers in the study above reported not thinking about their phones at all during the experiment. The students were oblivious to the disruptive, non-conscious force their phones imposed. In an experiment with a college lecture class (Lee, et al, 2017), students were randomly assigned to one of four groups: 1) Phone in possession and use permitted, 2) phone in possession but could not use, 3) complete removal of phone from possession), and 4) a control group where no instruction on cell phone use was given. The students who didn't take their phones into the classroom out-performed those that did by a full letter-grade on an exam (Lee, et al, 2017). The students with phones in class performed as poorly whether they used their phone or not. Another study of college students found even a phone powered down, when in view, diminished students' ability on demanding tests of attention and cognition (Thornton, Faires, Robbins, & Rollins, 2014).

In addition to debilitating effects on intelligence and attention, it seems smartphone technology also undermines interpersonal relationships. In one experiment, when smartphones were in the room, trust and interpersonal closeness was inhibited and diminished the degree individuals felt empathy and understanding from their conversation partners as measured by tests of affinity, trust, and empathy (Przybylski & Weinstein, 2012). In similar study, when a smartphone was in-view on a table, dyads in conversation found the quality of the conversation less fulfilling than the conversations where no device was present (Misra, Cheng, Genevie, & Yuan, 2014). Conversation partners with phones in view also reported less empathetic concern than those having conversations in the absence of mobile devices. The presence of a smartphone device produced the most deteriorating influence on conversation for participants who had the closest relationships.

With regard to social networks, one study found evidence of immediate and sustained reductions in well-being among Facebook users. The more participants used Facebook, the worse they reported feeling immediately after (Kross, et al., 2013). The more they used Facebook over the course of two-weeks, the more their life satisfaction declined over that period. Another study found using Facebook as an irrational delay of important tasks—what the researchers called Facebocrastination—increased students' academic stress and contributed to the negative well-being beyond the academic domain (Meier, Reinecke, & Meltzer, 2016). Finally, an additional study suggests heavy social media users may actually feel less and not more emotional support (Shensa, Sidani, Lin, Bowman, & Primack, 2015).

While the foregoing review was not exhaustive of all documented technological harms available in the literature, evidence suggests there may be at least four categories of computing technologies' deleterious effects:

Relational: Misra, et al., 2014; Przybylski & Weinstein, 2012

Cognitive: Ward et al., 2017; Thornton, et al., 2014

Developmental: Sparrow, et al., 2011; Ward, 2013

Psychophysiological: Becker, Alzahabi, & Hopwood, 2013 (depression & anxiety)

Fobain, Avian, & Schwebel, 2015 (sleep), Loh & Kanai, 2014 (neurological)

Views of Technology

The positive technology and positive computing literature do not address the existence of ICTs deleterious effects. Many scholars assume technology itself as a mediating agent has an inconsequential effect on individuals and society. Mostly, positive technologists and computer scientists do not entertain the possibility that individuals and societies change through the tools we use. Turkle (2011) argues that computing technology is itself neutral and that harm emerges when technology's provisions meet human vulnerability. Botella and colleagues (2012) state, "technology itself is neutral" (p. 78). Adam Alter (2017) agrees. "Technology is not inherently bad… Tech isn't morally good or bad until it's wielded by the corporations that fashion it for mass consumption" (p. 7-8).

The distinction between technology's role as an active force shaping civilization and as a neutral artifact is an important—and a contentious—one. On one side, like the scholars mentioned above, are instrumentalists: the most widely held view of technology that downplays the power of technology. Instrumentalists view technologies simply as tools– as artifacts subservient to the conscious desires and direction of users. At the opposite end of the spectrum are determinists, or technological determinists. Determinists assert that technological progress generates further technological advancement through autonomy of its own that exists outside of human control. Subsequently, determinists view technology as a transformative force that's played a major role in the course of human history.

The case for instrumentalism. For instrumentalists, technology is regarded as neutral, with no ethical valance; it is nor good nor bad. In the dogma of instrumentalists, technology lies in wait to be acted upon: technologies are inert until engaged and are inert once more when set aside (Carr, 2011). What matters is how technologies are used. In a 1955 speech at The University of Notre Dame, media mogul and pioneer at RCA and NBC David Sarnoff addressed criticism of mass media. "We are too prone to make the technological instruments the scapegoats for the sins of those who wield them. The products of modern science are not in themselves good or bad; it is the way they are used that determines their value" (as cited in McLuhan, 2003, p. 23). When considered in a specific context, the instrumentalist argument seems plausible. Individuals and people groups can and do make decisions on the use and application of technology. For example, the Old Order Amish in North America have shunned many modern technological affordances as informed by their religious beliefs (Carr, 2011). The Japanese banned firearms in the country for two centuries in an attempt to preserve the samurai culture. Today, individuals have the ability to power-down devices, choose when and how to use a given device, or disable notifications. A longitudinal perspective, however, suggests human control over the path or pace of technological progress has been limited.

The case for determinism. Iconic philosopher and communication theorist Marshall McLuhan found the instrumentalist position irreconcilable. "Our conventional response to all media, namely that it is how they are used that counts, is the numb stance of the technological idiot. A medium's content is just the juicy piece of meat carried by the burglar to distract the watchdog of the mind" (McLuhan, 2003, p. 31). In contrast to instrumentalism, determinism contends technologies shape how people think and act (Detel, 2015). Determinists assert technological progress has its own logic that unfolds in ways that may not be aligned with the initial intent or vision of the toolmakers or its users. In a dramatic metaphor of the determinist view, McLuhan (2003) reduces humans to "the sex organs of the machine world" (p. 68). In this extreme metaphor, McLuhan asserts the role of the human species is to develop increasingly sophisticated technologies—to "fecundate" machines as bees pollinate flowers—until the point when technology can reproduce and evolve on its own, rendering humans dispensable.

Viewing technologies through a historical lens sharpens the case for the deterministic perspective. For example, innovation in hunting and farming tools introduced changes in population growth, while efficiencies and new modalities of transportation gave way to new horizons in trade and commerce, and advances in weaponry shifted the balance of power between regions and people groups. "If the experience of modern society shows us anything, it is that technologies are not merely aids to human activity, but also powerful forces acting to reshape that activity and its meaning" (Winner, 2004, p. 105). Through a review of the historical context of the map, the clock, written language, the printing press, and physical spaces, proceeding sections provide the substance of the determinist case.

Clocks. The desire of Christian monks to be more dutiful in their prayer lives in the latter half of the Middle Ages eventually led to changes in the perception of time. In the majority of human history time has been regarded as a continuous, cyclical flow. The instruments that did track the progression of time emphasized natural processes: sundials, hourglasses, and clepsydras (water clocks). After clocks made their way from monasteries to the courts and residences of royals, they eventually became fixtures in city centers. At the same time, people started working in markets and mills instead of farms. The sound of the bells that began to accompany clock towers soon cued a litany of social interactions: the start of work, mealtimes, the end of work, the closing of city gates, the opening of the market, close of the market, assemblies, emergencies, council meetings, and so on. Days became chopped up into ever-smaller chunks of time. “The abstract framework of divided time became the point of reference for both action and thought” (Mumford, 1934, p. 15).

As communities started exchanging goods, synchronized timekeeping became required and the influence of public clocks expanded further (Landes, 1983). Along the way, clocks became smaller and cheaper and the personal timepiece eventually made its appearance. While the public clock introduced broad changes to daily life, the mechanical pocket watch and small household clock led to more personal consequences. The pocket watch became a persistent companion and monitor, reminding its owner of how much time they spent, used, wasted, or lost. The personal clock became “the prod and key of personal achievement and productivity. The personalization of highly measured time was a major stimulus to the individualism that was an ever more salient aspect of western civilization” (Landes, 1983, p. 92-93). The mechanical clock changed the way people viewed themselves and the way they thought. The clock played a significant role in bringing about the Renaissance and then the Enlightenment, ushering with it the scientific mind. “Once the clock had redefined time as a series of units of equal duration, our minds began to stress the methodical mental work of division and measurement. We began to see, in all things and phenomena, the pieces that composed the whole, and then we began to see the pieces of which the pieces were made. Our thinking became Aristotelian in its emphasis on discerning abstract patterns behind the visible surfaces of the material world” (Carr, 2011, p. 43).

Maps. As a medium, maps document, store, and communicate information representative of a specific territory. The widespread adoption of maps came along with the adoption of the cartographer's unique approach to perception, organization, and sense making (Robinson, 1982). In addition to the information a map conveys, it also embodies a particular mode of seeing and thinking. In this way, maps extended and shaped the intellectual advances they documented. Cartographic historian Arthur Robinson (1982) described the technique of mapmakers as "the use of a reduced, substitute space for that of reality." Maps took the idea of spatiality and translated it from a natural occurrence into an artificial and intellectual conception. "The combination of the reduction of reality and the construct of an analogical space is an attainment in abstract thinking of a very high order indeed. For it enables one to discover structures that would remain unknown if not mapped" (Robinson, 1982, p.1).

Written Language. The shift from oral culture to the predominately literary culture was brought about by the invention of the phonetic character alphabet (Wolf, 2007). Prior to the 24-character Greek alphabet, coming into existence around 750 B.C., the most advanced writing technology was the Sumerian and Egyptian logographic models. The volume of symbols in these models placed heavy demands on the brain and subsequently limited the number of people who could read and write cuneiform and hieroglyphics, respectively. The Greek alphabet was the first to simplify writing technology and became the model for subsequent western phonetic alphabets, including the Roman alphabet still in use today. "The economies of characters reduced the time and attention needed for rapid recognition, requiring fewer perceptual and memory resources" (Wolf, 2007, p. 217-218).

While language is not in and of itself a technology because it's native to the human species, reading and writing are not (Ong, 2002). As the primary vessel of conscious thought—

higher forms of executive thought in particular—technologies that shape and restructure language tend to exert significant influence over our intellectual lives. “Technologies are not mere exterior aids but also interior transformations of consciousness, and never more than when they affect the word” (Ong, 2002, p. 8). Research supports this assertion, finding that literate brains not only vary from illiterate brains in the way they process language, but how they process visual signals, how they reason, and how they form memories (Ostrosky-Solis, 2004).

Further innovation in written language liberated both the writer and the reader (Saegner, 1997). Even with the advent of the phonetic alphabet, reading was arduous and unnatural. Reading anything of length required an uncommon period of sustained focus. In addition, that period was often taxing because manuscripts were a continuous string of characters, without any break, on each line on the page. The lack of word separation, referred to as *scriptura continua*, was a reflection on language’s origination in speech. In spoken language, meaning was conveyed using inflection and other prosodic qualities of voice. When scribes put their pens to paper, they captured what they heard. Grammatical rules and conventions didn’t exist to govern the structure of words, phrases, and sentences (Saegner, 1997). The lack of word separation meant high levels of cognitive strain on readers—frequently pausing to re-scan lines of script, struggling to decipher where one word ended and another began and attempting to gather the text’s meaning along the way (Saegner, 1997). However intolerable this may seem to modern humans, it was likely of no consequence to individuals in a society rooted in oral culture. Yet, literate Greeks and Romans were known to have their books read to them by their slaves (Saegner, 1997).

Only after the fall of the Roman Empire did written language break away from the oral tradition and begin to introduce affordances unique to readers (Saegner, 1997). The numbers of literate individuals grew through the Middle Ages, spurred by the proliferation of technical reference material. Reading became a means of self-improvement and instruction instead of what had previously been an act of performance. Affordances to accommodate readers instead of orators began to appear in the new material. Chief among those affordances was the most significant innovation in written language since the phonetic alphabet: a predictable, standardized system of syntax (Saegner, 1997). In addition to the rules for word order in sentences, the beginning of the first century also ushered in the division of sentences into individual words. Soon after, punctuation appeared and by the thirteenth century *scriptura continua* was all but obsolete.

"The placing of spaces between words alleviated the cognitive strain involved in deciphering text, making it possible for people to read quickly, silently, and with greater comprehension. Such fluency had to be learned. It required complex changes in the circuitry of the brain, as contemporary studies of young readers reveal" (Carr, 2011, p.63). The intellectual faculties of readers were freed– because reading itself was less demanding, more cognitive energy could be placed on the interpretation of meaning (Saegner, 1997). Even individuals with modest intellectual abilities could comprehend inherently more complex texts. Readers also became more efficient and attentive, forging stronger neural links since it was less onerous to maintain focus over a sustained period of time (Bell, 2009).

These advances in written language transformed that act of writing, the subjects that were written about, and grew the number of writers (Saegner, 1997). With the advent of word spaces and a predictable system of syntax, an increasing number of individuals took up writing for themselves in private instead of dictating to scribes. This phenomenon led to writing that was more personal and adventuresome, giving voice to work that was unconventional, skeptical, heretical, and seditious- pushing the boundaries of knowledge and culture (Saegner, 1997).

Further, authors began to revise and edit their work, something not possible using dictation. Compared to the Middle Ages, an author could “see his manuscript as a whole and by means of cross-references develop internal relationships and eliminate the redundancies common to the dictated literature (Saegner, 1997, p. 249-250). In turn, authors’ arguments became longer, clearer, more complex, and more challenging. Likewise, paragraphs and chapter divisions began to appear in written works by the end of the fourteenth century.

In addition to transforming the personal experience of reading and writing, the advances in writing technologies discussed above also contributed to far-reaching social consequences. Universities began to emphasize private reading as an essential compliment to classroom lectures. Libraries began to play a more central role, while private cloisters and carrels were replaced with large, public open spaces where individuals could sit at long tables and read silently to themselves. Reference books, like dictionaries, glossaries, and concordances, appeared in libraries as important reading aids. Yet, the handwritten media meant there were a relatively small number of publications in circulation and a small number of individuals privileged with access to the publications. “The alphabet, a medium of language, had found its own ideal medium in the book, a medium of writing. Books, however had yet to find their ideal medium– the technology that would allow them to be produced and distributed cheaply, quickly, and in abundance” (Carr, 2011, p 67).

Moveable Type. Gutenberg’s printing press (~1455) brought together three technologies that would come to revolutionize the medium of the book: A small movable typeset cast in molten metal alloy, a refined wooden-screw press that he adopted from grape crushing to transfer the image of type onto parchment without smudging, and an oil-based ink capable of adhering to the metal plates (Eisenstein, 1980). The introduction of the octavo format around 1500, a smaller sized book compared to the folio format, made books even more affordable, convenient, and personal. Likewise, the invention of paper, imported from China, was cheaper than parchment and further fueled cheap production (Eisenstein, 1980). In the 50 years following the introduction of the printing press, the number of books produced equaled the number that had been penned by scribes in the preceding thousand years (Clapham, 1957).

By the beginning of the seventeenth century, printing presses were all over the world. Newspapers, scientific journals, and other periodicals were being published, in addition to books (Eisenstein, 1980). To keep up with the voracious appetite of a reading public, print shops began producing large editions of the classics in their original Greek and Latin, in addition to works by Shakespeare, Cervantes, Moliere, Bacon, and Descartes. The infusion of the older texts and works from masters of thought provided intellectual depth and historical continuity to the emergent literary culture (Eisenstein, 1980). In his 1620 book, *Novum Organum*, Francis Bacon (2000) notes the invention of moveable type “changed the face and condition of things all over the world so that no empire or sect or star seems to have exercised a greater power and influence on human affairs” (p. 100).

New editions of the classics and works of the masters weren’t the only publications that found an audience in the newly formed literary marketplace and not everyone shared an optimistic view of the growing literary culture (Eisenstein, 1980). Lowbrow publications appeared in the form of gutter journalism, propaganda, tawdry novels, quack theories, and pornography. In 1660, England’s first book censor declared, “more mischief than advantage were not occasion’d to the Christian world by the Invention of Typography” (as quoted in Raymond, 2005, p. 187). Eisenstein (1980) argues that the low-minded literary fare magnified the intellectual transformation of the printed book. They accelerated the spread of books into popular culture and made them a mainstay of leisure time. While cruder and more crass, lowbrow material helped spread the practice of—and subsequently the impact from—deep, attentive, reading. “The same silence, solitude, and contemplative attitudes associated formerly with pure spiritual devotion also accompanies the perusal of scandal sheets, ‘lewd Ballads,’ ‘merry books of Italie,’ and other ‘corrupted tales in Inke and Paper” (Eisenstein, 1980, p. 130).

“For the medieval type of brain, making true statements depended on fitting sensory experience with the symbols of religion. As books became common, men could look more directly at each other’s observations, with a great increase in the accuracy and content of the information conveyed” (Young, 1951, p. 101). Importantly, books allowed people to compare their thoughts, ideas, and arguments with those of others– outside the context of the religious dogma of clerics (Goody, 1977). Nearly everyone was granted to the ability to read and write. The literary revolution enabled political and religious upheaval, and bolstered the ascent of the scientific method to become the standard for defining truth and making sense of existence. What was once confined to monastic cloisters and the halls of universities was set free amongst the masses (Goody, 1977).

In the new dawn of the printing press, the constraints of language were routinely edited as the number of writers grew. As they attempted to compete for increasingly sophisticated and demanding audiences, writers captured thought with burgeoning clarity, elegance, and originality (Ong, 1982). As books proliferated, the vocabulary of the English language grew from a few thousand words to around a million words. These emergent words attempted to capture new, abstract concepts. Authors experimented with the syntax and diction of their prose, inviting readers to follow new pathways of thought and imagination. New literary devices introduced new ways of organizing and conveying information like lists, tables, formulas, and recipes

(Goody, 1977). These literary tools deepened thinking, giving intellectual life to new forms that aided more precise explanations and classifications of phenomena. The expansion of language deepened individual and social consciousness.

"The remarkable virtuosity displayed by new literary artists who manage to counterfeit taste, touch, smell, or sound in mere words required a heightened awareness and closer observation of sensory experience that was passed on in turn to the reader" (Eisenstein, 1980, p. 152). Like composers and painters, writers developed the ability to alter perception in ways that "enriched rather than stunted sensuous response to external stimuli, expanded rather than contracted sympathetic response to the varieties of human experience" (p. 152). Words did more than strengthen abstract thinking ability– they enriched the experience of the world beyond the page, of the physical world entirely outside of the book. New ways of thinking were made possible by the neural networks forged in the literate brain (Wolf, 2007). Since neural circuits developed by a given set of activities for one purpose can be leveraged for others, learning the sophisticated skill of reading and writing added to human's intellectual repertoire.

Physical space. In the Medieval era, most households consisted of a single-room home where seating was on benches as opposed to individual chairs and where whole families slept in the same bed with servants and sometimes even animals (Duby, 1988). Prior to 1500, privacy was understood as a domestic construct rather than a personal one. It was the household and the domestic unit that was dominant in the experience of private life. In fact, the word *self* does not appear in the *Oxford English Dictionary* until 1595 (Teske, 2002). The concept of a personal, private sphere, where the self is distinct from domestic partners, is a relatively recent cultural innovation. "It appears that the personal, private, interior notions of personhood upon which our contemporary sense of self and even of our spirituality depend are likely to have develop only as wealth and personal freedom enabled an elaboration of private, interior spaces and their extension into the metaphors by which we construct psychological interiors" (Teske, 2002, p. 695). New agricultural and construction technologies afforded the financial resources and technical means to build larger, more elaborate physical spaces that included distinct interior spaces. The emergence of "internal states" is a social and intellectual evolution that's situated within a symbolic "virtual" rather than a physical space (Teske, 2002).

The shifts in architecture have continued into contemporary and recent history and continue to shape the understanding of individuals and their psychological interiors (Teske, 2002). "The architecture of our intimacy has become more complex than it was for most of human history and is for most of the world" (p. 695). There are clear distinctions between domestic and communal public spaces and within them, a diverse set of architectural levels affording a broad range of privacy. In North America, the typical family home is a representation of the physical architecture of interiority. Homes are divided into grades of intimacy by the degrees of internal enclosure of the built environment (Teske, 2002). These homes often include semi-public foyers, seldom-used formal living or sitting rooms, a family room, eat-in kitchen areas, private bedrooms, semi-private working spaces for adults, designated areas for children, and a marital bedroom with restricted access. These attributes of modern physical interiors and the related implications for personal property, location, and individual expression are aspects of the evolving human domestic culture shaping the symbolic construction of privacy. Boundaries within defensible space, personal space, thought and mental life, and emotional expression are likely influenced by the physical nature of dwellings (Teske, 2002). Winston Churchill believed the British parliamentary democracy was created by the way the building was constructed. As he famously said, “we shape our buildings and afterwards our buildings shape us” (British Parliament, n.d., para. 1).

To wrestle with the considerations and implications of digital technologies’ deleterious effects presented at the beginning of this section, it is important to recognize existing orientations toward technology. Instrumentalists view technology as an entirely inert force to be acted upon by human will, while technological determinists hold that technological advancement compounds and tends to exert a force of its own on individuals and civilization as a result. Given the growing body of neuroscientific evidence supporting changes in the brain brought about by the recurring use of tools that supplement or extend the human nervous system (Ostrosky-Solis, Garcia, & Perez, 2004; Wolf, 2007), this work finds the determinist view more plausible, while not, per se, wholly inevitable.

Information and Communication Technology’s Potential for Harm

Understanding various technologies with a configurational awareness and consideration for the complete environmental situation makes clear their role in shaping individuals and civilizations over time (McLuhan, 2003). McLuhan himself was staunchly dedicated to understanding “not only the “content” but the medium and the cultural matrix within which the particular medium operates” (McLuhan, 2003, p. 23). McLuhan considered unawareness of the psychic and social effects of technology somnambulistic– to be sleepwalking. “There is little possibility of answering such questions about the extensions of man without considering all of them together. Any extension, whether of skin, hand, or foot, affects the whole psychic and social complex” (McLuhan, 2003, p. 5).

With this understanding and awareness in hand, I turn to an empirical and theoretical review of the basis for digital technology’s capacity to wield harm on the self and society. If the tools used to read, write, manipulate, and transmit information work on the human mind even as people work with them—and I assert they do—and in light of the research presented that these changes can be deleterious in nature, an important aspect of winning “an understanding of these forms that will bring them into orderly service” of human flourishing is to know something of digital technology’s basis or capacity for harm (McLuhan, 2003, p. 7). We ought to know intimately what’s at stake and what individuals and societies have to lose in order to appreciate what technology looks like at its best and advance the research and practice of Positive Computing.

As reviewed in the preceding section, the human capacity for language and the contents of mental life are inescapably social, architected by socializing agents and internalized in ways that morph across history through the adaptation of new technologies and evolving social practices. (Vygotsky, 1978; Luria, 1976). As noted, the word self did not appear in common lexicon until nearly 1600, The modern conception of *the self* is quite likely far different from that of our forbearers (Teske, 2002). Clocks became the ‘prod and key for personal achievement,’ while maps provided an architecture for abstract thought and eventually enabled farther, safer independent travel. Even as language developed and consciousness expanded, writing technologies and the medium of the book further strengthened individualism (Eisenstein, 1980). For centuries writing was rooted in the prevailing oral culture that emphasized communal development and propagation of knowledge. Writing was a means of recording more than it was a means of composition and the creativity of the individual was subordinate to the needs of the group. “The development of knowledge became an increasingly private act, which each reader creating, in his own mind, a personal synthesis of the ideas and information passed down through the writing of other thinkers” (Carr, 2011, p. 67). Silent reading became a means to and a signal of self-awareness. Once a personal endeavor, readers were transformed into the knower with responsibility for what is known (Carroll, 2007). The capability for independent research became a prerequisite for intellectual achievement. “Originality of thought and creativity of expression became the hallmarks of the model mind” (Carr, 2011, p. 67).

Just as the effect of clock technology has extended beyond the watch face and the effect of books extends far beyond the page, evidence suggests the effects of digital technologies reach well beyond the screen (Carr, 2011). Digital technologies present a new array of virtual spaces that blur the boundaries between the interior and exterior of the self– the “elaboration of virtual and symbolic interiors may involve the violation, renegotiation, and reconstruction of previous boundaries between self and not self, self and other, and the various levels of intimacy, privacy, and even isolation” (Teske, 2002, p. 696). Representations of the physical world like the desktop, windows, file folders, and the recycle bin were the original affordances used to introduce the graphical user interface of computer operating systems. Teskse (2002) reasons that these banal affordances of computing usability have led to the creation of radically new types of virtual spaces and have come along with entirely new sets of boundaries as the virtual is capable of being both interior or exterior, depending on the conventions for the way their created, maintained, and elaborated upon.

In some of the earliest work studying the effects of Internet use, conclusions were speculative and assertions tepid given the small sample sizes and limited predicates (Katz & Aspden, 1997; Kraut, et al., 1998; McKenna & Bargh, 2000). Nonetheless, researchers found evidence of loneliness and depression that was attributed to Internet, though it appeared short-lived and to a large extent, dependent on individual differences, goals, and needs. A small survey conducted by Katz and Aspden (1997) suggested that the Internet was generally capable of augmenting existing communities and forging new friendships. Kraut et al. (1998) produced results more critical of electronic communication and was the first to use the term “internet paradox”– implicating its functional use as a communication media may actually reduce social involvement, well-being, and social involvement.

Kraut and his colleagues (1998) found that the more participants used the Internet, the less they communicated with their family. Extroverted subjects were more likely to use the Internet less, while greater Internet use was found to reduce the size of people’s social circles. When controlling for wealth, gender, and baseline levels, greater Internet use correlated with increased loneliness and depression. Greater Internet use in adolescents showed larger declines in social support and increased loneliness. The McKenna and Bargh (2000) study reflected a more balanced view of the findings, highlighting the value electronic communication adds to real life relationships. Their findings on the web’s greater anonymity, reduced role of physical appearance due to changes in proximity and distance, and the ability to have more control over time and pace of interactions were supported by theoretical and empirical psychological literature.

Communicating via the Internet can offer greater anonymity, which is considered a major contributor to deindividuation. Deindividuation is characterized by increased impulsiveness and disinhibited behavior, including bluntness, hostility, and aggression, and reduced ability to form consensus (McKenna & Bargh, 2000). Subsequently, deindividuation can weaken self-regulation, reduce long-term planning, incite tendencies for emotional reactivity, and reduce awareness of the responses of others (Diener, 1980). Anonymity can also contribute to beneficial outcomes including greater self-disclosure, intimacy, and enrichment of usual role identities. Evidence suggests less nonverbal immediacy contributes to greater intimacy of conversation

(Argyle, 1975), which could mean the internet could allow people to develop closer relationships in shorter periods of time by virtue of making more intimate disclosures earlier in a relationship (McKenna & Bargh, 2000). However, intimacy also requires a modicum of reciprocity of disclosure (Altman & Taylor, 1973), and the Internet can exaggerate complexities with timing and mutuality. All the while, the Internet also presents unique means for expression, which provides opportunities for more playful self-presentation. The multiplicity of roles and sub-selves may create buffering effects against stress and contribute to increased better health and life satisfaction (Linville, 1985). This multiplicity could threaten a sense of a coherent self and contribute to disassociation and a compartmentalized fantasy self (Gergen, 1991).

In physical interactions natural interpersonal “gating” is produced by appearance and physical proximity and plays a role in relationship formation. In non-technologically mediated conditions, physical appearance normally plays a major role in relationship formation, especially between romantic partners (Hatfield & Sprecher, 1986). Digital communication that affords nonlocal, asynchronous communication has the propensity to enable deception and self-deception, given the propensity for strangers to behave with less modesty (Tice, Butler, Muraven, & Stillwell, 1995) and present a more idealized self (McKenna & Bargh, 2000). By the same token, electronic communication may also incite more dependence on similarity of values, interests, and conversational style, which could lead to deeper and more durable relationships (Teske, 2002). At the same time, the reduced role of physical proximity may make possible new interaction types and expose more readily familiarities and similarities, which are important to attraction (Byrne, 1971). However, a lack of physical proximity may also threaten the development of new interests, which are thought to be important aspects of psychological development and must be negotiated in long-term relationships (Teske, 2002).

Electronically mediated communication offers greater control over the time and pace of interaction. The affordance of temporality and a synchronicity means individuals do not have to be present at the same time, have greater freedom from interruption, and can edit their responses (McKenna & Bargh, 2000). While trading control for presence could reduce vulnerability of interaction, social penetration theory suggests that disclosure of increasingly revealing communication is required for healthy relationship formation (Altman & Taylor, 1973), so vulnerabilities in digital communication may not be avoided but rather delayed. Physical presence in relationship formation also contributes to shared emotion, mimetic communication, feedback about the timing and speed of conversation, and for the facilitation and coordination of activity, movement, and physical intimacy (McKenna & Bargh, 2000). With the exception of video chatting (e.g., FaceTime, Skype), electronic communication typically does not support normal signals of inattention, boredom, or other cues regularly used to modify responsiveness to a communication partner.

Privacy in the digital age can be understood within the theoretical context of human territoriality (Teske, 2002). Though rooted in mammalian territoriality, physical presence is not required, can involve multiple locations, and extends to abstract relationships (Altman & Taylor, 1973). Territoriality is also a major construct at play in the viability of mediating status, relationships, social systems, social unit formation, and the scheduling and regulation of interaction (Vinsel et al., 1980). As a mediator of social access, privacy is important to withdrawing from social contact and withholding information, as in situations of solitude, anonymity, intimacy, and reserve. Teske (2002) suggests the combination of physical privacy and psychological disclosure creates a paradox that may alter the functions of social access.

Increasing Internet use has the potential to influence with whom we interact and the kinds of relationships that are forged, but can also shape the way individuals understand the self as a social being (Teske, 2002). Importantly, social self-perception can include the incorporation of close relationships into important self-understanding. Digitally mediated communication leaves a void where physical embodiment would otherwise negotiate face-to-face relationships, where synchronization and reciprocation are important roles as facilitators of relationship development (Clark & Reis, 1988). Non-locality may also introduce limits to frequency and diversity of interchange, posing issues with timing, and restrict symbolic encoding, which may reduce wide-ranging interdependencies, which are also an important to healthy relationship formation. According to Baxter and Montgomery (1996), relationships always exist in dialectics between autonomy and intimacy, novelty and predictability, and disclosure and reservation, which are likely to be mediated differently by information and communication technologies. In close relationships, where there is a causal sequencing of actions heavily dependent on nonverbal signals, this may be especially true (Berscheid, 1994). Teske (2002) cites digital communication's dependence on symbolic language as the basis for the likelihood that ICTs will function mostly as a subsidiary to face-to-face communication, where reciprocity and matching of emotional and psychological investments cultivate trust– including the extensive, even bodily, self-with-other representations that are so important to intimacy (Aron, Aron, Tudor, & Nelson, 1991).

Interpersonal communication occurs through hundreds of simultaneously occurring channels, including facial expression, prosody of voice, movement and positioning of the body, gaze, and touch (Archer & Akert, 1988). These elements of nonverbal communication—key factors in emotional expression and relational interdependency—are starkly absent in electronic communication. Teske (2002) contends nonverbal communication provides most of our social architecture in the way they convey attitudes and relational status, including information about personality, closeness and intimacy, and the regulation of verbal interaction. Moreover, nonverbal communication may also satisfy physical needs. These extend from the cuddling, feeding, and care of infants, excitements and social negotiations of adolescence, and even needs in adulthood such as reassurance, affection, and touch. In addition to physical proximity's importance for mimesis in facilitating basic communication, shared emotions, reactions, and feelings, mimesis may play an important role in the evolution of language (Donald, 1991). Specifically, mimesis may be "the envelope within which more symbolic forms of communication have meaning" (Teske, 2002, p. 687).

Sherry Turkle, professor of Social Studies of Science and Technology at MIT, has been researching the implications of information and communication technologies for three decades. Turkle (2011) warns society has become particularly preoccupied with what technology can do *for* us with little consideration for what it may doing *to* us. According to Turkle, people have come to expect more from technology than they do from each other. Digital connection offers the illusion of companionship without the demands of friendship. In our networked lives, it is possible to hide from others even as it seems everyone is tethered to each other. Along the way, individuals have learned to romance their smartphones and have re-made themselves and their relationships with others thru a new intimacy with machines (devices). "We ask technology to perform what used to be love's labor: taking care of each other" (Turkle, 2011, p. 107). With this technologically engineered intimacy, relationships are reduced to mere 'connections.' These easy connections now define intimacy and this new intimacy is leading individuals into cyber solitude (Turkle, 2011). Evidence from neuroscience supports Turkle's findings. The higher human emotions, such as empathy and compassion, emerge from neural processes that are inherently slow (Marziali, 2009). When people are distracted, the less able they are to experience empathy, compassion, and other emotions. The brain needs time to move beyond or transcend the immediate involvement with its body in order to understand and feel both the psychological and moral aspects of a given situation.

There may be no better representation of Turkle's (2011) assertion of being "alone together" than the smartphone phenomenon. The smartphone's role as conduit to and for such an immense number of profound, constructive uses has turned it into what psychologist Adrian Ward (2013) calls a "supernormal stimulus." As a single point of convergence for a myriad of activities, access, information, and communication, the smartphone has become a television, radio, music player, mailbox, post office, newspaper, camera, photo album, public library, cookbook, a party with everyone you know in attendance, and—of course—a phone all in a singular device. Journalist and digital technology researcher Nicholas Carr (2017) notes the grip the smartphone possesses over human attention is unlike any natural object is capable of. "The way a media device is designed and used exerts at least as much influence over our minds as does the information that the device unlocks" (Carr, 2017, para. 23).

The rise of Internet addiction centers and digital detox programs indicate that overuse is becoming an increasing concern (Turkle, 2015; Alter, 2017). Nicholas Kardaras (2016), author of *Glow Kids: How Screen Addiction Is Hijacking Our Kids*, has found it easier to treat heroin and crystal meth addicts than video game or social media addicts. Alter (2017) proposes the addictive nature of digital technologies stems from the way that applications and devices leverage—consciously or not—the same ingredients of behavioral addiction. He identifies six ingredients that he contends are the same dynamics at work for other behavior addiction—like gambling—and hypothesizes that to some extent technology is irresistible because it leverages each to some degree (Alter, 2017, p. 9):

1. Compelling goals that are just out of reach.
2. Irresistible and unpredictable positive feedback
3. A sense of incremental progress and improvement
4. Unresolved tensions that demand resolution
5. Strong social connections

Adam Gazzaley and Larry Rosen (2016) reason that technology's allure resides in the way it resonates with the natural human tendency to seek information. Despite technology's role a powerful source of goal interference, which may induce a variety of negative consequences, its ability to feed the natural desire for optimal information foraging wins out.

Goal interference occurs when the pursuit of goals are challenged by distractions from relevant information and interruptions by attempts to pursue multiple goals at once. Goal interference "impacts every level our thinking, from our perceptions, decision making, communication, emotional regulation, and our memories. This in turn translates into negative consequences for our safety, our education, and our ability to engage successfully and happily with family, friends, and colleagues" (Gazzaley & Rosen, 2016, p. 5).

All complex systems are subject to interference and opportunity for performance interruption seems to scale with the system's complexity Gazzaley & Rosen, 2016). As the most complex known system, interference is a fundamental vulnerability of the human brain. Goal interference is so prominent in humans because of the complexity of human goals and the limitations involved with achieving them. Humans have highly evolved goal-setting abilities, with a more limited set of cognitive abilities. Sophisticated executive functions like evaluation, decision making, organization, and planning mediate the human ability to set goals (Gazzaley & Rosen, 2016). Carrying out goals is dependent on cognitive control– a set of abilities including attention, working memory, and goal management. “Our cognitive control is quite limited: we have a restricted ability to distribute, divide, and sustain attention; actively hold detailed information in mind; and concurrently manage or even rapidly switch between competing goals” (Gazzaley & Rosen, 2016, p. 9).

Despite the effects of goal interference, people routinely undertake interference-inducing behaviors or insert themselves in interference-inducing situations. Gazzaley and Rosen (2016) hypothesize that humans engage in interference-inducing behaviors because, from an evolutionary perspective, human beings are acting in an optimal manner to satisfy an innate drive to seek information. Their hypothesis is based on Eric Chanov’s (1976) optimal foraging theory called the Marginal Value Theorem (MVT) that predicted the behavior of animals that forage for food. What originally existed in the brain to support food foraging has evolved to support information foraging (Hills, 2006). At the core, humans are information seeking beings. Evidence suggests the dopamine system relates directly to information-seeking behavior in primates (Bromberg-Martin, & Hikoska, 2009). Accordingly, Gazzaley and Rosen (2016) assert that modern information technologies are only a proxy for the true change to our mental landscape: information as ultimate commodity. “Evidence strongly supports the evolution of goal-directed cognition out of mechanisms initially in control of spatial foraging but, through increasing cortical connections, eventually used to forage for information” (Hills, 2006, p. 3).

Research suggests that humans naturally organize their environments to maximize information intake and consumption (Pirroli & Card, 1999). At the same time, the less-advanced abilities of cognitive control mean that humans have fundamental limitations in the way they process information (Gazzaley & Rosen, 2016). As such, people engage in behaviors that intend to maximize exposure and consumption of new information, but end up causing interference. Amidst the sea of media and devices for connection and consumption that vigilantly offer information at-the-ready, this hunger for information is fed to an extreme (Gazzaley & Rosen, 2016). For example, when a user senses a diminishing return or depleting information available as they scroll through their Instagram feed—that their effort is not yielding optimal results—an internal prompting arises, perhaps experienced as boredom or anxiousness, signaling it is time to move on to a new source where information may be more dense. Just a squirrel moves from patch to patch foraging for nuts until she senses a diminishing return on her effort, in the model of information foraging, so too do humans move digitally from "patch to patch," optimizing the consumption of information at each stop.

With information almost instantly accessible and an insatiable drive to consume this information, it's certainly an attractive notion to believe information and communication technologies have made humans smarter (Sparrow, Liu, & Wegner, 2011; Wegner & Ward, 2013). While research on new media's effects on intelligence and learning ability has found growth and sophistication in the areas of visual-spatial skills, it has come at the cost of a weakened capability for deep processing (Greenfield, 2009). This deep processing is what undergirds the mindful acquisition of knowledge, inductive analysis, critical thinking, imagination, and reflection. These deficiencies implicate another finding about the human relationship with information. Dubbed the *Google effect*, anticipating information will be readily available in a digital format reduced the effort made to remember it (Sparrow, Liu, & Wegner, 2011). "Because search engines are continually available to us, we may often be in a state of not feeling we need to encode the information internally. When we need it, we'll look it up" (Sparrow, et al., 2011, p. 777). According to this research, individuals can't distinguish between the information in their heads and information in their phones, in the cloud, or online. "The advent of the information age seems to have created a generation of people who feel they know more than ever before even though they may know less about the world around them" (Wegner & Ward, 2013, An All Knowing Friend Section, para. 8).

Moreover, information is essential for thought. Possessing information is a prerequisite to sense making. As William James wrote, "Remembering is the art of thinking" (James, 1897, p. 101). Because accessing information is possible at any time, in almost any location via smartphone, it appears the brain may be offloading the work of remembering to technology (Sparrow, Liu, & Wegner, 2011). Information must be encoded in our biological memory in order to sew the tapestry of intellectual associations that form personal knowledge and develop critical and conceptual thinking capacity. "No matter how much information swirls around us, the less well-stocked our memory, the less we have to think with" (Carr, 2017, para. 25)

Gazzaely and Rosen's (2016) hypothesis on optimal information foraging and its impact on goal interference implicate a multitasking epidemic amongst the heaviest digital technology users. Some teenagers report handling six to seven types of media simultaneously (Carrier, et al, 2009). According to cognitive neuroscientist Jordan Grafman, it is possible to make improvements on the brain's ability to multitask (Tapscott, 2009). At the same time, however, any improvements in multitasking are granted at the cost of impaired ability to be creative and think deeply. "The more you multitask, the less deliberative you become– the less able to think and reason out a problem" (as quoted in Tapscott, 2009, p. 108-109). As a result, the multitasking brain tends to settle for conventional ideas rather than offering new lines of thought.

Evidence suggests heavy multitaskers are also more likely to be distracted by irrelevant stimuli in their environments, possess less control over working memory, and have a diminished ability to maintain concentration on a given task (Ophir, Nass, & Wagner, 2009). The performance of multitaskers in research studies suggests they sacrifice performance on the primary task in order to accommodate other sources of information. In his analysis of the research, Clifford Nass noted that multitaskers' vulnerability to the irrelevant left them prone to let almost anything distract them.

The Potential for Positive Computing

There exists a space between the inevitable and the unsupportable future of technology (Turkle, 2011) and Positive Computing may be uniquely equipped to steward the scientific prism of human potential. To realize the full potential of Positive Computing, it is important to recognize the domain of Positive Computing exceeds the bounds of computer science and positive psychology and ought to be situated in a more universal context with consideration and contributions from a range of fields, domains, and disciplines. Second, digital technology's deleterious effects cannot be ignored, must be addressed, and hold value to understanding how computing technologies can be designed most positively. Third, we must discover the positive elements of information and communication technologies. Positive Computing scholars and practitioners must work across the boundaries of disciplines to uncover the intrinsic aspects of technology capable of increasing human capacity for well-being. Fourth, we need to bring to life a new framework of design that abandons the deficit-based model. Finally, we must harness the power of the arts to anticipate the future of techno-social developments. Ezra Pound considered artists the antennae of the human race, able to act as an early warning system (McLuhan, 2003).

What if this posture of deep awareness could change the way the world sees, buys, and consumes technology?

Greater Than: A Transversal, Social Constructionist Paradigm

Positive Computing is much larger and its implications more profound than two fields of scientific study. It begs important questions that are ethical, epistemological, and ontological in nature. It bears implications for the use of technologies in a myriad of cultures and in places all over the globe. To pursue such an audacious undertaking, Positive Computing must employ a transversal approach that is sensitively situated in the broad context of the social complex.

Generally speaking, Marshal McLuhan was a technological optimist– even noted as an advocate for a “technology-utopia.” He saw a radical vision for the future, which he believed was enabled by electronic communication and digital technology (McLuhan, 2003). McLuhan envisioned a future where the Western world broke free of the prison imposed by a literary culture that rendered individuals detached and society uninvolved. “Rapidly, we approach the final phase of the extensions of man– the technological simulation of consciousness, when the creative process of knowing will be collectively and corporately extended to the whole of human society, much as we have already extended our senses and our nerves by the various media” (McLuhan, 2003, p. 5).

While McLuhan’s highest view of technology may not have been predicated on an explicit intent to leverage technology to cultivate human flourishing, he possessed an unrelenting confidence for what he believed humanity was capable of. He considered the aspiration of the 20^{th} century to be the pursuit of wholeness, empathy, and depth of awareness and believed achieving them was a natural use of electronic technology. In his lifetime, he detected a collective eagerness for all things and all people to experience their whole selves. “There is a deep faith to be found in this new attitude – a faith that concerns the ultimate harmony of all being" (McLuhan, 2003, p. 7).

Like McLuhan (2006), Teske (2002) expresses an optimistic view of electronic communication's future. To Teske, an expansion of the interior is a conduit for greater inclusivity. Digital technology's ability to connect people with a more diverse network of humans could play a significant role in broadening the interior of the self. "To the extent that Internet usage can reduce our obsessions with unique, egocentric individualities or reduce our belief that we can exhibit autonomy outside of our extensive interdependency, it may provide a greater awareness of the symbioses we share with the real, objective, external, social nexus of our species and even of our planetary ecology" (Teske, 2002, p. 697). It seems Teske arrives to this conclusion by reasoning the essence of the human condition is the ongoing construction of symbolic virtual realities.

Yet, McLuhan was acutely aware of the influence technologies have on the broader 'psychic and social complex' (McLuhan, 2003). Simultaneously with his optimistic vision of the future, McLuhan understood that every technology changes the human condition. He recognized the effects of technology are often subversive, that they may go unnoticed, and in turn advocated for the honest appraisal of what may be lost as well as gained in any advent of new technology. "The effects of technology do not occur at the level of opinions or concepts, but alter patterns of perception steadily and without any resistance" (McCluhan, 2006, p. 31).

Teske, likewise, maintains a sober consciousness of technology's deleterious capabilities. Teske raises a litany of provocative questions concerning "how these proliferating forms of electronic communication, accessed by users from places of solitude, might have an impact on our sense of intimacy, on how we construct the boundaries of self and other in relationships, and on how we understand our own virtual interiors as we multiply and elaborate them" (Teske, 2002, p. 696). When someone is absorbed in a video game, what is interior and what is exterior to that experience? Is that experience public or private? Within close relationships, what is interior and what is exterior when things can be said to someone online, but not in person? Does technology facilitate the fabrication of memories about communication efforts or contents of communication? Does digital technology deepen relationships with others or render them shallower? Are relationships made more or less accessible? Are people inevitably hiding from themselves as they lose or misplace access to virtual libraries of life content generated in novel media formats dictated by the platform, network, or app du jour? Is the relationship with the self deepened or made shallow through technology? Can ICTs be used to enrich a personal sense of integrity, meaning, purpose, and focus, or does it inevitably lead to incoherence, fragmentation, and isolation?

In the shadow of the sections of this work that implicate a growing body of evidence on digital technology's harmful effects and the psychological bases of those harms, Teske's questions are particularly salient. The inconvenience of considering the influence of information and communication technologies on privacy and sociability, the formation and maintenance of relationships, nonverbal behavior, and the way we understand our own embodiment can no longer be entertained.

Ironically, some the most notable titans of the technology industry limit the use of technology in their own homes (Alter, 2017). Steve Jobs did not allow his kids to use the iconic iPad that his company, Apple, created. Citing the dangers of technology he's seen first-hand, Chris Anderson, the former editor of the technology-focused magazine, *Wired*, maintained severe technology use limits in his home. Evan Williams, founder of Blogger, Twitter &

Medium, refused to purchase iPads for his kids and insists they read only physical books. Psychologist Adam Alter (2017) compares the titans of tech to drug dealers who know it is wise to 'never get high on your own supply.' "This is unsettling. Why are the world's greatest public technocrats also its greatest private technophobes? Can you imagine the outcry if religious leaders refused to let their children practice religion?" (Alter, 2017, Prologue, para. 5).

What makes these anecdotes about the private lives of these technology leaders particularly disconcerting is the degree to which they seem to understand the deleterious potential of the ICT products and services they sell. These technology icons appear to recognize that while their technologies are extensions of human ability, they ultimately become part of what and who people are (McLuhan, 2003). What's more, they don't seem convinced these changes are necessarily a good thing. Why else would they keep their technologies from their children? These stories speak to an important implication Positive Computing must address: the individual's plight as technology consumer. Developed and deployed within a capitalistic system intended to keep people coming back for more—that is, to serve as the engine of an ever-expanding economy—what exactly would lead an enterprise to develop a piece of technology for any other reason than financial gain? McLuhan (2003) suggests once introduced, technology creates its own world of demand through a magnetic cycle of continuous use that is independent of what the technology is being used for. The content, or programming, matters less than the presence of the technology. As a result, people's entire sensory experience goes up for lease to commercial interests. If an individual becomes what he attends to, as William James (1897) suggests, and if our attention—accessed through any one of our technologically connected senses—can be sold off to the highest bidder, where does that leave society? "Once we have surrendered our senses and nervous system to the private manipulation of those who would try to benefit from taking a lease on our eyes and ears and nerves, we don't really have any rights left" (McLuhan, 2003, p. 99).

McLuhan's warning penned in 1964 was prescient then and startlingly true 53 years later. According to Sean Parker, co-founder and the first president of Facebook, Sean Parker, the company founders intentionally created the social media platform to be addictive and exploit human psychology (Silverman, 2017). From the outset, the intent of the company was to consume as much of people's time and attention as possible through a social-validation feedback loop. "And that means that we need to sort of give you a little dopamine hit every once in a while, because someone liked or commented on a photo or a post or whatever. And that's going to get you to contribute more content, and that's going to get you . . . more likes and comments" (Silverman, 2017, para. 7). Parker confessed, "God only knows what it's doing to our children's brains" (Silverman, 2017, para. 2). He further hypothesized Facebook produces unintended psychological consequences and estimated what empirical evidence has shown consistently. "It literally changes your relationship with society, with each other… It probably interferes with productivity in weird ways" (Silverman, 2017, para. 5)

According to Marx's theory of historical materialism, the economic base of a society determines its superstructure (Detel, 2015). In turn, the superstructure creates certain conditions that necessarily predicate what and how something exists within that system. Positive Computing scholars and practitioners ought to consider digital technology's existence in a commercial system and the myriad of related implications. In a system of commerce, the benefits of technology are generally framed and delivered in a way where recipients are "consumers." Just as viewing patients as individuals that need things done *to* and *for* them can undermine health outcomes, technologies that are 'consumed' may very well produce similar effects (Freire, &

Sangiorgi, 2010). In a consumer model, by definition, one entity creates value, while another destroys it. Scholars and practitioners alike ought to consider how value can be co-produced and co-created to redefine the exchange of value when it comes to technology. The way corporations will grapple with producing technologies that not only avoid harming people but facilitate human flourishing is largely yet to be seen (Calvo & Peters, 2014). A business entity may have little interest in in delaying potential short-term gains for the enterprise, which would mean potentially fewer immediate hedonic rewards for users, in exchange for benefits that require long-term investment. Are the financial gains of an enterprise and the psychological well-being mutually exclusive? Can positive computing exist within a commercial system? To address these issues forthwith, Positive Computing must reach beyond its current academic and practical scope.

Won't we just evolve anyway? Isn't that just what we do– isn't that what we've done throughout history? Is it even worth attempting to intervene? Surely our brains just need to evolve to adapt to consume more dense amounts of information faster. Are there ever scenarios where technological harm is tolerable? Do scenarios exist where the use of technology is critical to life or death where the benefits are far outweighed by the consequences of harm? What about using technology to deliver learning, healthcare or civic support even in the face of ongoing harm? Is some harm inevitable? Does anything exist without some harmful side effect? Raising livestock, operating automobiles, operating factories, generating and using electricity, and consuming goods all come with some negative impact on the planet and on people. Is computing technology any different?

I argue doing nothing in the face of the present evidence of digital technology's harm is a bit like arguing "the climate has always changed so why worry about it now?" Technologies have always changed civilization, so why worry about their effects now? An abundance of perspectives support the notion that the pace and impact of digital technologies is and will continue to be exponential as compared to other technological innovations throughout history (Kurzweil, 2005). This is likely to make the impact of our modern technological extensions of humanity to be unlike anything before. No other technology in history has involved the artificial intelligence enabled, personalization and social influence manipulation in every aspect of life at an unrelenting pace occurring around-the-clock. Technology ethics advocate, Tristan Harris, argues there is a major distinction between modern computing technologies and early mechanical tools and predicate electronic media like television and radio (TED, 2017). Harris contends the fundamental difference lies in the coordinated effort of designers and developers that is required on behalf of companies to enable the use of computing technologies. In this way, a small number of people are scripting the activities and behaviors of billions. Autonomy is being programmed away from individuals.

There is sufficient evidence that suggests the future of technology can be different. A distinctive hallmark of our human condition is the ability to reflect on what disposition will make us most effective, most happy, well off, and fulfilled. Notwithstanding the pace of change, we would do well to remember that digital technologies are still their infancy. Computing technologies are constantly evolving and are perennially unfinished. It is not too late. But how do we move forward? How are the economic and social forces effectively addressed in a way that doesn’t just mitigate harm, but builds what’s best about people, society, and technology? In the face of what has been presented here, how might we move forward with an approach that is truly positive?

We must firstly view civilization as a living, human construction. It matters what we believe society, humanity, and indeed technology is capable of. What a civilization considers to be true is created through socially constructed historical narratives and theories of events (Whitney, Cooperrider, & Stavros, 2008). These narratives determine what people—scientists and laypersons alike—are able to see. As a result, observations are filtered through conventional stories, belief systems, and theoretical lenses. In this way, the way of knowing is fateful (Gergen, 1994, 2004). This idea, that a social system determines or creates its own reality is known as social constructionism (Whitney, Cooperrider, & Stavros, 2008). What is known—social knowledge—exists in the stories of the collective, where it is created, maintained, and employed by the group. This dialogue that is necessary to determine the "nature of things." Value knowledge or social theory is, therefore, a narrative creation, not an aspect of the physical world. Social knowledge is not "out there" in nature to be discovered through detached, value-free, observational methods (logical empiricism); nor can it be relegated to the subjective minds of isolated individuals (cognitivism)" (Whitney, Cooperrider, & Stavros, 2008, Chapter 1, Section 2, para. 11). In essence, the way human beings think about talk about the human condition shapes the very experience of being human (Schwartz, 2015).

Accepting the theoretical and empirical evidence that humans change by and through the social systems we create and therefore by the way we live and through the tools we use abandons the instrumentalist view. It does not, however, necessarily subscribe us to the determinist perspective. Understanding the dynamic, transformative power of technologies within the social nexus should be seen as separate from the fatalistic view that technologies necessarily and ultimately dictate the destiny of civilization. The social constructionist approach offers an alternative to the poles of instrumentalism and determinism. Moreover, Appreciative Inquiry (AI) places the social constructionist framework in a positive context and is a useful model for developing a broader, more sensitive paradigm of Positive Computing. "Appreciative Inquiry is the cooperative co-evolutionary search for the best in people, their organizations, and the world around them. It involves the discovery of what gives "life" to a living system when it is most effective, alive, and constructively capable in economic, ecological, and human terms" (Whitney, Cooperrider, & Stavros, 2008, Chapter 1, Section 1, para. 1). Informed by Appreciative Inquiry's basis in social constructionism, Positive Computing scholar-practitioners can develop a more comprehensive, sensitive framework.

In the constructionist view, social knowledge and a society's destiny are inextricably interwoven. Several scholars have concluded the underlying images a culture or civilization envisions for itself has tremendous influence on its fate (Whitney, Cooperrider, & Stavros, 2008). Effectuating societal change occurs through the construction of stories, ideas, beliefs, meanings, and theories embedded in language. That means people and societies move in the direction of their inquiries. In this way, the seeds of change are planted within the questions used to elicit images of the future. "The rise and fall of images of the future precedes or accompanies the rise and fall of cultures. The image of the future can act not only as a barometer, but also as a regulative mechanism that alternately opens and shuts the dampers on the mighty blast furnace of culture. It not only indicates alternative choices and possibilities, but actively promotes certain choices and in effect puts them to work in determining the future" (Polak, 1973, p. 300).

By attending to the brightest and boldest, most illuminating, and promising positive images, Polak (1973) contends humanity can forecast its probable future. According to the heliotropic hypothesis, human systems have an observable tendency to evolve and move in the direction of these positive images (Whitney, Cooperrider, & Stavros, 2008). As a flower grows in the direction of the sun, so too do human systems grow toward positive visions of the future. Projecting and affirming positive images of the future as if they already exist like a projector on a screen develops our metacognitive ability. Metacognition is the awareness of, knowledge of and insight into the workings of an individual's own cognitive system (Ashcraft, 1997). Individuals, societies, and entire civilizations possess the ability to develop metacognitive capacity and choose positive ways of construing the world.

Metacognitive capacities are required in order to understand the totality of technology's abilities and the full extent of its threat to optimal human functioning. It is imperative to address technology's capacity to erode human potential while simultaneously drafting a collective positive vision of the future in which technology plays a responsible, ethical role that enables unprecedented degrees of humans flourishing. “Any culture which finds itself in the condition of our present culture, turning aside from its own heritage of positive visions of the future, or actively at work in changing these positive visions into negative ones, has no future” (Polak, 1973, p. 300). The responsibility of Positive Computing scholars and practitioners is to ensure the positive images of the future are truly positive and are capable of cultivating human flourishing. To do this, new ways of knowing are required. "Because styles of thinking rarely match the increasingly complex world, there must be a commitment to the ongoing pursuit of multiple and more fruitful ways of knowing” (Whitney, Cooperrider, & Stavros, 2008: location 719). The collective basis of constructing the future involves and considers every aspect of society and is the best possible means of imaging and effectuating what is truly positive. “Between the intellectual and behavioral guardrails set by our genetic code, the road is wide, and we hold the steering wheel. Through what we do and how we do it—moment by moment, day by day, consciously or unconsciously—we alter the chemical flow in our synapses and change our brains” (Carr, 2011, p. 49)

Everyone An Artist

Looking across the history of human culture, McLuhan (2003) suggests artists as the rare member able to detect, foresee, and anticipate the deleterious harm of technologies decades before their influence is realized. To McLuhan, artists possess “the exact information of how to rearrange one’s psyche in order to anticipate the next blow from our own extended faculties. In experimental art, men are given the exact specifications of coming violence to their own psyches from their own counter-irritants or technology” (McLuhan, 2003, p. 97). What the work of artists provide are prescient learnings from the future to make conscious adjustments to personal and social life in the present through models to face the future or ‘Noah’s arks’—as McLuhan termed it—for enduring the changes at hand. “The ability of the artist to sidestep the bully blow of new technology of any age, and to parry such violence with full awareness, is age-old” (McLuhan, 2003, p. 96).

Not an artist? According to McLuhan you can be and you ought to be. “The artist is the man in any field, scientific or humanistic, who grasps the implications of his actions and of new knowledge in his own time. He is the man of integral awareness” (McLuhan, 2003, p. 96). Artists are men and women of ‘integral awareness.’ To extend and infuse the artists’ awareness into society McLuhan calls for a move from the ivory tower to the control tower of society. With a position in the control tower of society and a will to be exceedingly informed and aware, it is possible for scholars and practitioners in Positive Psychology and beyond to prevent undue wreckage in society.

This awareness must be brought to a more rigorous and comprehensive definition of positive technology. It is insufficient to singularly invoke technology as a means to enable, extend, and implement mechanisms that cultivate human flourishing without understanding the broader social nexus using a metacognitive perspective. It’s this type of awareness and wisdom typified in Joseph Weizenbaum's (1966) warning to avoid the allure of entrusting technology to handle tasks that require wisdom. Computers follow rules, they do not make judgments. In place of subjectivity, they operate on formulas. Using the social constructionist approach, understanding a broader framework for Positive Computing, where the interrelationships between conceptual frameworks, related psychological disciplines, and individual constructs require further study. The academic community owes further study to the scholarly commons and practitioners to the people whose lives will be affected by the products and services they design.

From our collective control tower, can we foster a culture that is mindful of the technologies being developing and how they're developing them? Can the artists' mentality make its way into commerce and prompt consideration about extending our humanness because *we should*—because it offers builds ability for human flourishing—not simply because *we can*. It is worth noting the thoughtful consideration of the emerging evidence on the harms of computing technology has a way of inciting certain pessimism about a cyborg future that looks all but certain. Journalist Nicholas Carr remains optimistic. "But I continue to hold out hope that we won't go gently into the future our computer engineers and software programmers are scripting for us" (Carr, 2011, p. 224). This requires the development of macro and micro views of Positive Computing theory and intervention science. It must be understood and defined in broad terms, within a social nexus, accounting for the cumulative impact of technology use; and it must be defined in tactical ways that can help inform the design of technology applications, down to the interactions between human and machine. We require evidence of the positive to inform technological innovation so that we might design the right things and in turn, design those things in the right way.

Defining the positive in positive computing. Scholars' and practitioners' responsibility in taking up the ethos of McLuhan's "artisanal," integral awareness concerns the ongoing stewardship of what constitutes the *positive* in Positive Computing. What defines a technology as positive? To what extent is the positive-ness of a technology element held constant? How might we consider differences in degrees of positivity? While this definitional work is an entirely ongoing endeavor, I suggest Pawelski's (2016a) five descriptive components of the positive reviewed in the section on positive psychology as a logical starting point: orientation, topography, context, process, and the ultimate aim of the field. As a matter of course in consideration of each element, I suggest primers to further the definition of the *positive* in Positive Computing:

Orientation**:** Positive psychology is a necessary compliment to psychology-as-usual. What role should positive computing play in everyday, constructive technology applications? In what ways should it cultivate the faculties of human flourishing? We have identified negative effects that need to be attended to, but simply mitigating their harm will only render technology "not bad." The positive is not the same thing as the absence of the negative.

Topography: Positive psychology introduces new topics of study such as character, virtue, optimism, and hope. How might computing technologies build the self-acceptance, positive relationships, autonomy, and purpose in life? To what extent should everyday technologies that function mostly as extensions of productivity and efficiency support these positive aspects of mental life?

Context: Those receiving clinical care are not the only people who can benefit from psychological interventions. Positive psychology opens the benefits of cultivating what's best to, for, and within everyone. Does this widened context implicate a universal application of positive elements in computing technology? Are there limits to the breadth of the scope? For example, a virtual reality cognitive behavioral therapy (CBT) session may not constitute as positive application, in the case it is with a clinical population. But might the same session be considered positive with a non-clinical participant? Might the intervention for a clinical patient be considered positive if it employs the related orientational approach, topography, and context that characterizes the descriptive nature of positive psychology?

Process: Positive psychology is focused on the mechanisms that build the positive qualities of an individual. How might computing leverage existing human strengths to invoke what makes life worth living? What can we learn about the intrinsic positive processes of technology that may hold implicit ability to cultivate well-being like the effect of being in nature has on the psyche?

Ultimate aim: Positive psychology's ultimate aim is he pursuit of the good life. Ought every application of technology intend to cultivate the good life? Are there occasions where technology ought simply to provide us utility, without, per se delivering a net positive?

In addition to these questions in the descriptive context, Pawelski's (2016b) normative definition offers a further basis to grow the depth of the positive in Positive Computing. The normative definition has two components: An inclusion criterion of simple preference and continuum criteria that explicate the degree something remains positive. The simple preference something means something is preferred as compared to its absence. This need not hold across all frames of reference, but it must hold for at least one. The second component of the normative definition consists of five continuum criteria, where something can be more or less positive depending on the way it holds across the criteria (Pawelski, 2016b). For both parts of the definition, and specifically with regard to ICT, frames of reference are an important consideration. Accounting for shifts in broad or narrow frames of reference may change if or to what degree something is positive. These continuum criteria are especially helpful given digital technology's tendency to persistently, pervasively shift frames of reference. The simple preference and continuum criteria also offer a valuable prism that can help develop the metacognitive awareness of computing's influence to weave into the narratives we take up with others to construct the world we want to live in.

Relative preference: Something may be relatively preferred if it is preferred to something else. When it is preferred to all other things it is considered optimal (Pawelski, 2016b, p. 362). What technologies are preferred to others? Are there types of technologies that we can unequivocally determine are optimal?

Sustainability across time: The more positive something endures, the more positive it is (Pawelski, 2016b, p. 362). This begs questions of technologies frequency of use and considerations for developing technologies that support flourishing over time. How might we design for hedonic adaptation in technology applications? Could artificial intelligence help create applications and experiences that are generative and change to deliver what is psychologically positive in that moment?

Sustainability across persons: The more people for whom something is good, the more positive it is (Pawelski, 2016b, p. 362). How might we further understand what aspects of technology perform consistently positive across people groups? How ought computing technologies compensate for cultural differences?

Sustainability across effects: When something is in and of itself good, it is considered positive. When something good leads to other good things with fewer bad effects, it is more positive (Pawelski, 2016b, p. 362). If we understand what aspects of computing technology are most effective in facilitating well-being, might we begin to understand how to create a stacking effect or a domino effect that creates an upward spiral? Might we also be able to understand how positive technologies can displace harmful side effects and in so doing, begin to make them irrelevant?

Sustainability across structures: Things that are good for the individual or local structures are positive. When something is scalable and transferable across organizational and culture contexts it is more positive (Pawelski, 2016b, p. 362). How might be understand, anticipate, and deploy a large technology application that cultivates flourishing at scale? How might we avoid the harmful effects of the likes of Facebook or Instagram and only experience their benefits?

In addition to serving as a starting point to continue the work of maturing the definition of the positive in Positive Computing, Pawelski's (2016b) normative definition can also be used to evaluate individual aspects of digital technology or applications. Considering these factors has the ability to help scholars and practitioners make decisions about what technologies to deploy or how to experiment more responsibly with a given technology. In the evaluation of a technology's positive-ness, considering the concept of the positive as "fractal flourishing" is helpful (Pawelski, 2016b, p. 363). Fractals, as commonly referenced by a piece of broccoli to the entire stalk, are relationships among the parts where the same pattern is repeated at every scale. The fractal approach avoids thinking in terms of tradeoffs, where the absence in positivity in one place may mean sacrificing the well-being of the few for the many. "Fractal flourishing, on the other hand, is an ideal that hold for the well-being of individuals *and* groups, that values happiness in the short-term *and* in the long-term, and that seeks approach that work locally *and* globally" (Pawelski, 2016b, p. 363). Pawleski's fractal flourishing is the essence of the artists' integral awareness McLuhan (2003) encourages.

Finally, scholars, practitioners, and scholar-practitioners must bring their integral awareness into their areas of research. Studies designed to measure positive outcomes should also include mechanisms to measure potential deleterious effects of technology-enabled interventions or solutions. Further, more fine-grained study is required to understand what patterns of use, interactions, gestures, and interfaces are most capable of cultivating human flourishing.

In Consideration of Harm

If we drink from the well but the source is contaminated, is the benefit not infected? Does the contamination not undermine its nourishment? Positive Computing scholar-practitioners ought not to ignore the growing body of evidence indicating technology's harmful effects. Likewise, we cannot assume these harms exist in a vacuum. It appears that deleterious effects are possible whether a technology is leveraged for constructive and positive applications alike. It appears the bounds of Positive Computing ought to apply to the full ubiquity of technology applications and Positive Computing's responsibility thereof ought to be thoughtfully considered.

Positive Computing scholars and practitioners ought to be steadfastly vigilant about the explicit and unintended harmful side effects technology may produce. "How sad it would be, particularly when it comes to the nurturing of our children's minds, if we were to accept without question the idea that "human elements" are outmoded and dispensable" (Carr, 2011, p. 224). Turkle (2011, 2015) suggests human brains are designed to care for other humans and not machines. She contends the function of caring for others plays an important role in human development. Does using technology as an education aid in every subject from literacy to mathematics reinforce an unhealthy attachment to machines– one that is undermining critical aspects of individual psychological maturity?

Even in the case of technology-enabled positive interventions, where technology is explicitly used to build resilience, identify thinking patterns, spot thinking traps, or train active-constructive responding, its deleterious effects could displace the would-be benefits. While we're attempting to build a resilience skill of connection (Reivich & Shatte 2002), we would be remiss to further understand how a mechanism like technology can simultaneously make people less capable of connection (Turkle, 2011). While we're attempting to foster mental agility and optimism (Reivich & Shatte 2002), we ought to be fully apprised of the reduced capacity for problem solving, erosion on attention and focus, feelings of isolation, and anxiety and depression that technology can cause (Greenfield, 2015). With information and communication technologies still in their infancy, it seems foolish to assume we understand how technology may be simultaneously displacing the positive benefits (the positive paradox) and undermining the constructive benefits of technology, leaving people somehow diminished.

McLuhan (2006) understood that every new medium changes us. When he noted *the medium is the message*, he was observing technology's ability to create an entirely new environment that reprocesses the old environment. These new environments are not passive wrappings of their contents, where content of electronic mediums are the mechanized tools of the industrial age, but are rather active processes. If scholars and practitioners are not vigilantly aware, the technology of a medium, however novel it may be, is eclipsed by whatever content flows through it. Herein lies the danger of misunderstanding new mediums or technologies as simply a new way to do an old thing. A focus on the content—for example, smartphone apps that keep us organized, keep us connected, and even help us meditate—can end up blinding us to the effects of the technology. When it comes to its influence on how thought and behavior over time content matters less than the medium itself. “As our window onto the world and into ourselves, a popular medium molds what we see and how we see it– and eventually, if we use it enough, it changes who we are, as individuals and as a society” (Carr, 2011, p. 3).

New mediums shape and control the scale and form of human association and action (McLuhan, 2003). Extending ourselves with technology comes with psychological and social consequences the Positive Computing field must consider. The new patterns and design amplify and accelerate existing processes of human life.

> All media work us over completely. They are so pervasive in their personal, political, economic, aesthetic, psychological, moral, ethical, and social consequences that they leave no part of us untouched, unaffected, unaltered. The medium is the message. Any understanding of social and cultural change is impossible without a knowledge of the way media work as environments. All media are extensions of some human faculty – psychic or physical. (McLuhan, 2003, p. 26)

The message, therefore, of any technology is the change of scale, pace, or pattern that it introduces (McLuhan, 2003). As scholars, practitioners, and scholar-practitioners, we must consider what may be lost with each new extension of the self. McLuhan (2006) warned that with every extension something else is amputated. Positive Computing scholars would be remiss to make an assumption that technology universally adds more than it takes away or that what it adds is more positive than what existed before. For example, in an analysis of 34 million scholarly articles published between 1945 and 2005, James Evans (2008) found that as academic publishing became more digital, scholars cited a fewer number of articles. As older print articles were made digitally available scholars tended to cite recent articles more often. Search engines and filtering tools ended up amplifying popularity, which quickly established, then reinforced consensus about information's relevancy. What should have conceivably led to the broadening of academic research with a more diverse set of citations, actually led to a narrowing of science and scholarship.

Part of the metacognitive ability Positive Computing must take up is an awareness of the confluence and dynamic relationshipsof technologies as a source of potential harm. For example, the phenomenon Turkle (2011) notes—being 'alone together'—does not stem from one app, one device, one feature, or one deviant product, but instead, from a confluent affect created by the interrelationship and a *new environment* created by a digital, screen culture. As a result, the effects extend beyond effects during use and affect other, analog activities. Digital technologies such as smartphones are "so entangled with our existence that, even when we're not peering or pawing at them, they tug at our attention, diverting previous cognitive resources. Just suppressing the desire to check our phone, which we do routinely and subconsciously throughout the day, can debilitate our thinking. The face that most of us now habitually keep our phones nearby and in-view magnifies the mental toll" (Carr, 2017, para. 13).

An intimate understanding of digital technology's capacity to erode and reduce human potential is important not just to avoid, compensate for, or fix them. Knowing what causes harm is about replacing harmful technologies and applications with those that build the capacity for well-being. Without knowing what causes harm, scholars and practitioners may be unintentionally developing solutions that leave people less well-off than before they engaged a technology or intervention. Furthermore, it's important to emphasize that the approach to technological harm ought not be deficit-based. Our goal is not limited to the identification and mitigation of harm, but to understand harm to the extent that technologists and designers are able to make those harms irrelevant with new technologies designed for well-being.

Discovering Technologies' Inherently Positive Traits

Within Positive Psychology, a positive approach necessarily builds up what is good and cultivates the factors of that contribute to flourishing. While we have learned much about what elements of the human condition cultivate optimal human functioning, we do not know the same about the mediating elements of information and communication technologies. Introducing these mediating elements has the potential to alter the context and the responses of the targeted psychological elements and systems. One of the unique hallmarks of digital technologies is its pervasive and ubiquitous nature as a medium in a diverse set of contexts, situations, activities, and industries. As such, the various aspects of ICTs—devices, patterns of use, activities, functional area of support—must be better investigated to understand to what degrees the aspects of ICT *in and of themselves* are able to intrinsically contribute to well-being. We need to understand the “strengths" of ICTs in order to design applications that leverage the attributes of those strengths. Domains form education to medicine to law leverage technology to extend the practices of those respective fields and afford their services greater reach and scale (e.g., apps that teach mathematics and literacy in education, decision support applications in medicine, and digital documentation repositories in law). Nearly every vertical stands to gain by understanding the inherent positive aspects of computing technologies.

Just as writers gained the ability “to alter perception in a way that enriched rather than stunted sensuous response to external stimuli, expanded rather than contracted sympathetic response to the varieties of human experience,” (Eisenstein, 1980, p. 46) in what ways might digital technologies have similar effects capable of cultivating well-being? Just as character strengths are the building blocks of well-being (Park, Peterson, & Seligman, 2004), we ought to understand what aspects of technology are natural supporting elements of optimal human functioning. What properties of digital messaging are more effective at building positive relationships? Do emoji have inherent psychological benefits? Are personifications of individuals in a digital form, like Apple's new animoji, capable of positive influence on the psyche? What types of touchscreen gestures engender psychological benefits? Under what conditions? What can we learn by conducting comparative effectiveness research between digital and analog modes of communication? How might we understand what aspects of technology and its use cultivate meaning?

It is important to consider what actually constitutes a *positive* benefit. In a study of a computer game where one version of the software was designed to be user-friendly with on-screen help and another bare-bones version with no provided guidance, users of the "well-designed" program performed worse than the users of the barebones program (van Nimwegen, 2008). While the players of the user-friendly game initially solved the puzzles more quickly and with fewer wrong moves, the players of the less helpful program demonstrated the ability to plan ahead and plot a strategy. Even eight months later, the players who had originally used the unhelpful program solved puzzles nearly twice as fast as those who had used the well-designed, helpful software. Van Nimwegen (2008) concluded it was the differences in the design of the software that accounted for the differences in learning and performance. When users could not rely on their machines for help, they internalized the problem solving operations themselves, while those who used helpful interfaces outsourced the cognitive effort to the machine. This study is an acute implication for a systematic questioning of assumptions about what is truly constructive and what constitutes a positive psychological benefit.

A New Model of Positive Design

While some have suggested that HCI has moved beyond addressing the basic needs and goals of users and, as such, moved toward supporting high-order needs and goals (Zhang, et al., 2009), I find little practical evidence of this in published work or within outcomes. I resonate more closely with the perspective of Kanis and Brinkman (2008): “Naturally, most practitioners in the field of HCI aim to give the user a high-quality experience with technology, but designing technology that actually contributes to people’s happiness in their everyday lives is a more complex challenge. There is clearly an opportunity to employ technology for positive change, but how this can be achieved is more difficult to determine” (p. 127).

Building technology in a way that avoids harm and supports human flourishing will not happen by accident. Building technologies that build the faculties of optimal human functioning requires an explicit intention to achieve positive outcomes (Desmet & Pohlmeyer, 2013). The judicious selection of what technologies to employ and how those technologies are used is also required. Neither of those requirements is possible using the prevailing, deficit-based Human-Computer Interaction frameworks developed at end of the 20th century. We would be naive to expect using the same frameworks—even where explicit positive intent is present—to achieve anything other than adoption, user acceptance, or usability objectives. To produce technology applications capable of cultivating human flourishing, a new design model is required. In order to achieve extensions of humanity that empower greater well-being, we must design for positive deviance, not ‘user acceptance.’ The metrics we use to evaluate our technology systems must be more profound than productivity, efficiency, and reliability.

Peter Desmet and Anna Pohlmeyer (2013) have proposed a framework for design that promotes human flourishing–what they have termed *positive design*. As their argument goes, just making a technology application *not bad* doesn't make it *good*. Positive design seeks to understand the basis of available science and go beyond the aim of diminishing the bad (frictions of use), and exploit the ability to influence subjective well-being. This requires an intentionality to accomplish positive potential and a broad contextual scope to adequately understand the fullness of the human condition. While grounding in what constitutes harm is lacking (frictions of use versus more deleterious effects), Desmet and Pohlmeyer's (2013) work is an important addition to the Positive Technology and Positive Computing literature and ought to be leveraged as a stepping-stone to reimagine a positive-based design model.

A critical aspect in the development of a new, positively oriented model of design is to avoid seeing every challenge or problem as a technology problem or problem to be solved with technology. "In a user-centered approach, technology becomes the focus of a solution where methods are targeted at the closure of technology-centered problems, rather than an investigation of suitable changes to a system of human activity supported by technology" (Gasson, 2003, p. 29). To understand the factors contributing to the positive application of technology, designers must begin with an understanding of the values, preferences, and behaviors of the *humans* for whom a solution is being designed. This requires employing a human-centered approach versus a user-centered approach. The difference is in the ability to view humans as *people* instead of as *users*. While this may appear a matter of semantics, a *user*-centered perspective constrains the definition of an individual to their relationship with a machine and therefore limits the human-centeredness of the solution (Gasson, 2003). By contrast, the human-centered perspective considers individuals in the fullness of their whole being—their social, cognitive, emotional, physical and cultural needs. The attunement with these considerations offers the best opportunity to provide technologies that cultivate flourishing and avoid harm. It is imperative to evaluate considerations beyond the modeling of individual interactions with a computing system in order to deliver positive value.

In this way, design ought to be viewed holistically, as the synthesis of problem exploration and solution definition. The information systems perspective of technology design, mentioned earlier, takes a view of human agency that reduces human-centeredness to those considerations needed to facilitate an individual's interactions with a computer interface (Gasson, 2003). In contrast, the positive design model within an expanded paradigm of Positive Computing requires a socio-technical basis to balance the requirements of two competing systems (Gasson, 2003, p. 31):

1) A social system of interacting human activities, multiple, implicit (and often conflicting) goals, human understanding and knowledge, business context and application-specific cultures and practice.
2) The technical system of formal, rule-based procedures and technology, managed by performance indicators and exception-handling.

In this re-calibrated approach, a systems-level view aims at redesigning technology systems in view of and with consideration for universal influences. It avoids the "band aid approach" where technology is thrown at technology in hopes of making it less harmful, more palatable, and hopefully "positive." The Space for Humanity Beacon made by the company Ransomly is a device that can be introduced into a family environment and activated to block the Wi-Fi signal (Ransomly, 2017). The beacon is intended to create technology-free family experiences to facilitate connection with family members without the competition of digital devices. These types of devices are arguably required as interstitial efforts as more designers, technologists, scholars, and practitioners take their posts in the control tower of society, but these efforts are not sustainable and further, they are certainly not a wholly positive approach to the problem. It would seem that "fighting" technology with technology would likely exacerbate the root issues and further compound the basis of harm.

As we learn about what harms and what helps, I recognize there may be room to be more gracious with our definition of "positive" in the short term. Since it appears there are so many hidden factors in the design, development, and deployment of technology, perhaps a measure of latitude ought to be granted. What I fear is that by tolerating loosely conforming *positive outcomes* they will become "enough"—as sufficient—and further investigation into technological harm and its intrinsic benefits will sit idle. Further, generating reams of rules– dos and do-not's for technology use also appear insufficient. Usage guidelines for young children, like those published by the American Academy of Pediatrics, make good sense (Healthy Children, 2016). Parents ought to be stewarding how a child spends their time and what playthings are engaged. For adults, however, exhaustive technology rules are unsustainable. Moreover, these rules are ameliorative. The idea that we have to keep ourselves from harm or protect ourselves against technology will not serve us well in the end. Even in the case of children, designers can do better at understanding and leveraging technology applications to cultivate well-being in youngsters to begin with. While technology users ought not be completely absolved for their responsibility, the greatest burden rests on the technologist and design practitioners to create meaningful pieces of technology that empower optimal human functioning. For that, a new model of positive design that breaks away from the current deficit-based Human-Computer Interaction framework is required.

Conclusion

It is easy to get caught up in the benefits and conveniences computing technology affords us. Journalist Nicholas Carr writes, “The computer screen bulldozes our doubts with its bounties and conveniences. It is so much a servant that it would seem churlish to notice that is also our master” (Carr, 2011 p. 4). Likewise, once aware of digital technology’s deleterious effects, it can be tempting to become a hyper-skeptical Luddite. There is certainly convincing evidence that technology changes us, how we see ourselves, how we relate to others, how we think, and how we act. Yet, we need not see technology as an unbridled force running roughshod over humanity, dictating what we do and who we become. I have asserted by adopting a transversal, social constructionist paradigm Positive Computing can enable humanity to choose what it becomes and how we go about becoming. Scientific discoveries have liberated us from the falsehood that we have only one destiny. Social constructionism theory and new perspectives on the mind-brain relationship indicate humanity possesses within itself the awareness, attention, and intentionality required to steer the trajectory of our civilization.

Tristan Harris, the technology ethicist mentioned earlier, has built an organization called *Time Well Spent*, to bring awareness to the importance of considering where people’s time and attention is placed (Time Well Spent, 2017). This is the type of organization and movement that will bring us into metacognitive integral awareness. What Harris is acutely right about is computing technology’s nature as critical infrastructure. As this work has argued, Harris makes an urgent call to examine the influence of digital technology on mental health, democracy, relationships, and our children. The orientation of Time Well Spent, however, views technology as a problem to be solved. While the organization advocates for a balance for on-and off-screen time and activities, it constrains our humanity to a relationship with computing technology anchored in a deficit model. Breaking humanity free of its present attentional prison requires more. The transversal, social constructionist paradigm of Positive Computing I've presented is an able liberator.

This paper has argued that we cannot simply accept the existence of technology's deleterious effects. Nor can we solely focus only on eliminating the harm, as doing so would only get us to a state of "not bad." Further, only focusing on the good technology can do leaves the damaging effects unchecked, jeopardizes the benefits of the good uses, and keeps technology applications in the "good zone" at the cost of leaving the truly *positive* underdeveloped. Similarly, a focus on developing technology's positive capacities still leaves technology's deleterious abilities unchecked, ignores what intrinsic or inherent harmful effects may exist, and leaves the intrinsic or inherent ameliorative benefits unexplored. Does technology have intrinsic ameliorative effects–like nature provides the human psyche, like the sun delivers vitamin D, like the way relationships support well-being? Today, the inherent nature of technology is mostly studied from a negative perspective, while the positive lens has been used primarily to consider the methodological or functional perspective. Both are required for a complete grasp of Positive Computing.

This essay is a call to arms for positive psychology scholars, practitioners, and scholar-practitioners alike. It is not just a call to consider how technology is applied in commercial and clinical contexts, but also a call for a metacognitive awareness that considers who we are, who we want to be, and the role of computing technologies therein. While it has not been the predominant frame throughout this work, much of what has been discussed is of moral and ethical fiber. Part and parcel of transversally setting Positive Computing within the social nexus necessarily demands evaluation of right and wrong, good and evil, help, and harm, and by what doctrine of human value we enlist as our compass. In such endeavors of consequence, integral awareness is primordial.

We need a more robust definition of positive technology that accounts for its dynamic complexity to guide us forward. We must delve deeper into the discrete effects of technology on various situational contexts and person-to-person differences. We must pursue a deeper understanding of the functionally positive and the inherently positive aspects of technology. We must intentionally identify socioeconomic systems in which technology acts as a reinforcing agent.

We ought not blindly embrace, nor rush away from technology in a panic. Let us find instead a worthy opportunity to consider first our humanity and the heliotropic opportunities it affords us. Our collective metacognition can ensure technologies' deleterious effect do not unwittingly undermine its benefits and will allow us to profoundly understand computing technology's full positive potential. In so doing, I hope you'll envision with me a future that's more about the connection between people than connected devices. I hope you'll see a tomorrow that's about pulling people together instead of pushing the limits of technology. In closing, once more the work of Marshall McLuhan delivers– this time, an invocation: “There is absolutely no inevitability as long as there is a willingness to contemplate what is happening” (McLuhan & Fiore, 1996).

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