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Book Review

ERIK BRYNJOLFSSON and ANDREW McAFEE. *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. New York, NY: W. W. Norton, 2014. 320 pages. ISBN-13: 978-0-393-23935-5. $26.95 hardcover.

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In 1965, engineer Gordon Moore famously predicted that the number of components per integrated circuit would doubleannually, allowing 65,000 components to fit into a single integrated circuit by 1975. Advancement of digital technology and its rapid assimilation makes it difficult to imagine our world without it. Advances in the past decade have moved us from cell phones to smartphones, from video cassette recorders to digital video recorders, and from paper charts to electronic medical records. Video game consoles in 2006 offered as much computing power as supercomputers used in nuclear weapons simulations nine years earlier. Even more amazing, that same console accomplished in one square foot and 200 watts the same amount of computing that required 1,600 square feet and 800 kilowatts (Brynjolfsson & McAfee, 2014, p. 49). Alongside the convenience of maps at our fingertips digital technology is also changing society, economics, and even basic human interaction. When new technology emerges and advances so rapidly, there is inevitable lag in society's adaptation to it. In their book *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies* Erik Brynjolfsson and Andrew McAfee offer examples of the tremendous capabilities emerging through digital technology and discuss the economic benefits and challenges resulting from such rapid change. When one considers these changes as a psychiatrist, even more intriguing questions emerge about the human capacity to adapt.

Brynjolfsson and McAfee offer three core observations. First, humanity is in the middle of a period of astonishing evolution of digital technologies. In line with Moore's law, the capability of digital technology continues to double roughly every one to two years. Transformations that occur as a result of the explosion of digital technologies will be profoundly beneficial. The average person today can access a greater variety of goods and services, produced and distributed more efficiently, and typically of better quality. The transition to digital technology is not without significant challenges, and progress will leave some in society behind. The changes wrought by digital technology on economics so far have not been entirely beneficial. *The Second Machine Age* offers an entertaining, enlightening, and thought-provoking treatment of these topics.

Not since the introduction of the steam engine in the 18th century has society confronted such a transforming advance as digital technology. Starting in the late 18th century, combustion, electrification, and mechanization shifted massive segments of the world economy from small, local, and primarily agrarian production into large,

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multinational, and industrial production. Industrialization took place over 200 years and multiple generations. In contrast, digital technology first appeared in the middle of the 20th century and has advanced orders of magnitude faster than the mechanical technology of the Industrial Revolution. Tasks once deemed impossible are now routinely accomplished through digital technology. Many readers are accessing this article in an electronic format that did not exist 20 years ago. How different that pace of advancement is compared to an early-20th-century farmer admiring his son's mechanical tractor, the first in the county.

Advancement of technology in the digital age is exponential, digital, and recombinant, according to Brynjolfsson and McAfee. Exponential progress follows Moore's law: capacity and capability double approximately every 12 to 18 months. To put this in perspective, at the end of a 75-year human life span computing power will be 10^{15} times what it was at birth. To describe progress as digital emphasizes that advances occur via an unending stream of ones and zeros—bits of information. Not only are these bits inexpensive to reproduce, they can be accessed almost infinitely and never used up. As a result, information can be reproduced and disseminated widely at a minimal cost. Digital progress further exploits this digitization of information through increased ability to network information, thereby increasing its value. Brynjolfsson and McAfee present the real-time traffic application Waze as powerful example (pp. 58–60). Waze gathers speed and location data from many users. The application combines all these small pieces of information from subscribers and returns to them recombined and more valuable information on traffic conditions and recommendations for alternate routes. The value of each user's information increases as the total number of users increases—a network effect. Google recognized the value of this networked information, purchasing Waze for $1 billion (Vindu, 2013). Waze also demonstrates the recombinant nature of digital progress. To describe progress as recombinant means that innovation is not the result of a few brilliant entirely new ideas but rather the result of more efficient powerful combinations of existing ideas. Combining crowdsourced information with mapping technology to provide real-time traffic information did not require inventing a completely new technology but rather took advantage of a powerful new combination.

What then is the impact of this explosion in digital technology on society and the economy? According to Brynjolfsson and McAfee (2014), understanding the impact of digital technology requires understanding the concepts of bounty and spread. Thanks to digital technology, the average worker produces in 11 hours what it took 40 hours to produce in 1950 (p. 99). Digital technology not only improves process efficiency and labor productivity, it makes greater variety of higher quality goods available to a broader consumer market. Digital technology adds potential value streams in the form of intellectual property, process optimization, user-generated content, and human capital. While this would all seem positive, the increased bounty of digital technology has also increased the spread of assets. The rising tide of digital technology has not only failed to lift all boats; it may actually submerge a few. Median income in the United States actually declined 10%, going from a high of $54,900 in 1999 to $50,000 in 2011 (p. 129). In that time the top 10% of earners increased their share of national income to over 50%, with the top 0.01% of earners taking in more than 5% of national income. Digital technology amplifies this concentration of wealth through two forces. Individuals with skills enabling them to take advantage of digital technology command a higher wage in the current market compared to unskilled workers. Skill-biased change led to high school dropouts earning less in 2012 compared to 1963, while college graduates earn four times more (p. 135). At the same time, those individuals who control digital technology or intellectual property

derived from it earn even more as digital capital can be reproduced at little or no cost. Although prosperity increases overall, it does so with an increasing share of the profit going to those controlling digital capital and a decreasing share going to those who labor. Wage share of gross domestic product decreased from a historical average of 64% to 58%, while profit share increased from 20% to 26% in just three years (pp. 144–145). Big winners become bigger winners, and those previously just getting by find themselves increasingly disadvantaged.

Rapid changes brought by digital technology and the increased spread of wealth should generate interest among psychiatrists, psychologists, and mental health providers as much as economists. As digital technologies displace entire occupations, workers face the challenge of sustaining themselves and their families. The primary stress of loss of income is compounded by the stress of finding a new role in an economy that may or may not value a particular worker's skills. Digital technology enhances the search for employment with a greater range of opportunities available, rapid and convenient access to that information, and ability of the individual job seeker to rapidly and inexpensively reproduce and transmit his or her personal information to a large number or potential employers. Unfortunately, that same job seeker can have rapid access to an endless stream of media stories about tremendous successes of the few lucky individuals with the skills and capital able to take advantage of the new marketplace. Where will the balance fall of benefit versus impairment from digital technology for each displaced worker? The concentration of wealth and assets by those holding digital and intellectual capital will generate significant discontent among those parts of society that recognize their disadvantage. An effective therapist will understand not only the role digital technology plays in creating and perpetuating an individual's distress but also the potential solutions offered.

Exponential expansion of digital technology presents further challenges to consider. At what point does the rate of environmental change exceed the capacity of humans to adapt? Will we face a surge in depression and anxiety complaints in the face of individuals' inability to change their thoughts and behaviors to accommodate smartphones and interconnected devices? Are there ways in which the human mind is adapting to this explosion of digital technology that may not be in our best interest in the long run? The movie *Wall-E* presents us with a future in which humans have become so sedentary that they turn into obese blobs endlessly consuming digital entertainment while an array of technology tends to all of their physiologic needs. *DSM-5* proposes Internet gaming disorder as an indicator of the power of digital technology to hijack our brain reward systems as powerfully as alcohol or any other substance. Cyberbullying extends the reach of those wishing to harm even into the safety of one's home. Less threatening, but equally concerning, children increasingly communicate digitally to the exclusion of face-to-face interaction. The same trend appears to be increasing among adults as well. What will be the nature of our interpersonal communication 10 years from now, and are we ready for it? Smartphone applications offer cognitive-behavioral therapy—without the physical presence of a therapist. Psychiatry must adapt to these challenges as much as the mail sorter displaced by a digital scanner.

To be certain, the expansion of digital technology has brought tremendous benefit to society. Brynjolfsson and McAfee challenge us to consider unanticipated consequences of this growth, particularly the spread of wealth. Their book offers public policy suggestions aimed at addressing the economic changes brought about by digital technology. Psychiatry and mental and behavioral health should take this discussion into our own realm and consider the implications of digital technology on human capacity to adapt and the

consequences of failure to do so. Further, we need to consider our future responses as our patients increasingly struggle with understanding their place in an increasingly digital world.

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