Vice President's Conversation on the Future

Trend Research: Technology Change and Adaptation

Descriptor Definition

This paper examines trends in the advancement of the expanse of technologies (e.g. digital information, communication technologies, automation); innovation; accessibility, security, and personalization; rates of adaptation among governments, businesses, industries, and individuals.

Authors' Insights[1]: Descriptor Relevance

Technology, which has progressed at an exponentially rapid pace over the past several decades, is poised to be completely transformative once again by 2035. According to recent predictive reports, technology experts agree that by the year 2025 technology will have progressed to mobile and wearable devices... embedded computing will be tied together in the Internet of Things, allowing people and their surroundings to tap into artificial intelligence-enhanced cloud-based information storage and sharing (Anderson & Rainie, 2014). Technology is the most influential driver of behavioral change in culture. For example, mobile phones were unheard of among the general population until the early late 1990s to early 2000s. By 2005, cameras were introduced. In 2008, the first truly "smart" mobile phones went mainstream. Within a decade, human behavior has been dramatically augmented in terms of how we communicate, share, and work with one another. In 2012, 80% of smartphone users utilized their phones for mobile banking. Sixty percent did not go more than an hour without checking their phone (Kadlec, 2012). In 2014, 41% of Americans used their device to coordinate a meeting or get-together, and 29% described their mobile phone as "something could not live without" (Duggan, 2014).

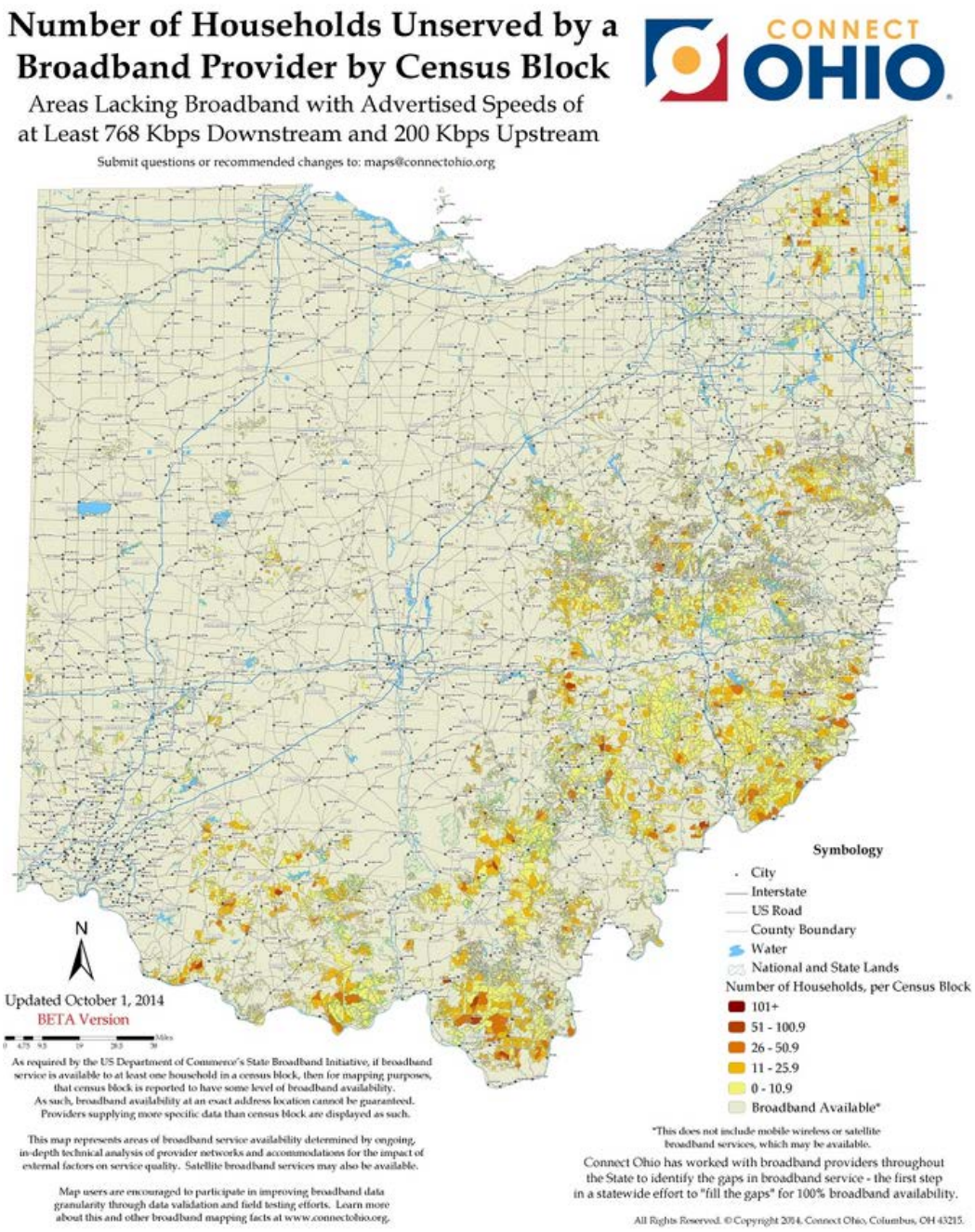
While mobile phones have transformed human behavior, even more changes are in the near future. Experts predict that technology will continue to extend and expand in the next decade and beyond, revolutionizing human interaction, especially affecting health, education, work, politics, economics, and entertainment (Anderson & Rainie, 2014).

Trend Information & Interpretation

Access to Technology

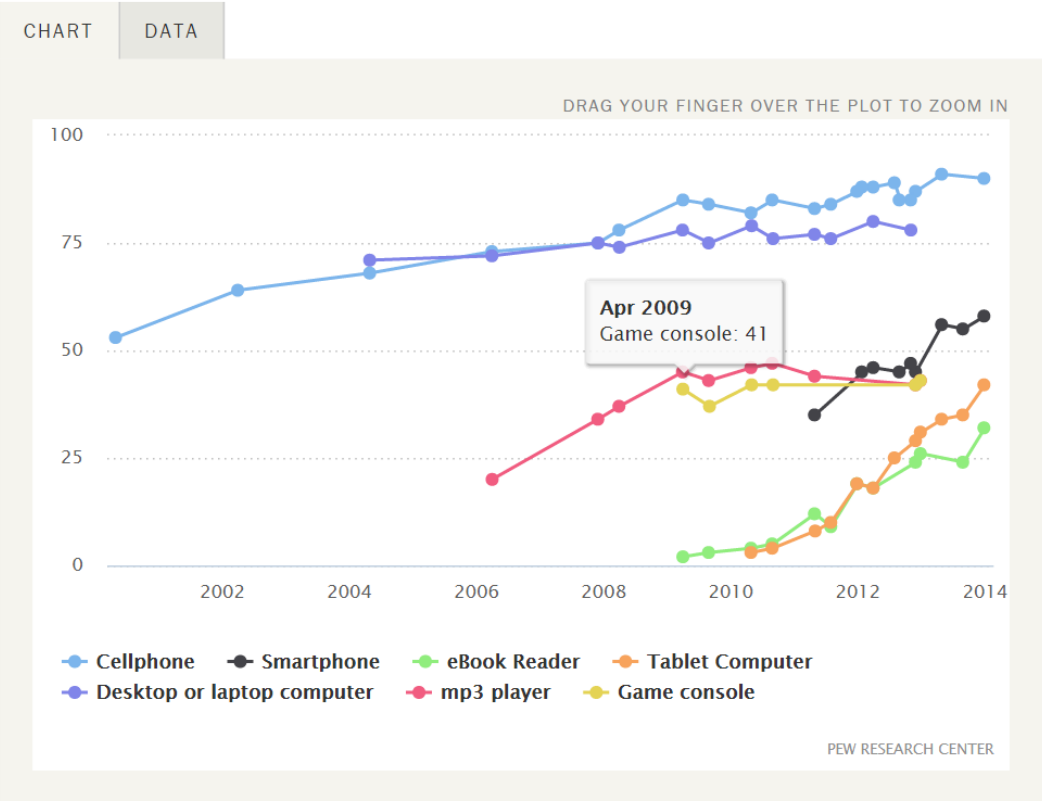
According to a January 2014 Pew Research Center report, 90% of American adults own a cell phone. Fifty-eight percent own a smartphone (Duggan, 2014). While most Ohioans own a cell phone, mobile service access continues to be an issue in certain portions of the state including the southeast Appalachian region. Broadband Internet service also experiences gaps in coverage around the state, though minimal. The Connect Ohio initiative aims to increase broadband coverage, which over time, will lessen gaps the gaps that exist (Figure 1).

Figure 1.



Even with service gaps, Ohioans and Americans in general tend to own more than one mobile device. In 2014, 32% of American adults owned an e-reader and 42% owned a tablet computer (Figure 2).

Figure 2.



Individuals who own more than one device tend to be members of the middle to upper classes and are predominantly white. This highlights one aspect of what has become known as the *Digital Divide*. On one side of the divide exist the "haves": those who have access to information that technology provides access to. On the other side of the divide exist the "have nots": those who do not have the monetary or even geographical means to access information that technology provides. Many impoverished Ohioans and Americans access the Internet via their smartphones, the only device they may own. While accessing the Internet from a phone may allow individuals to study, work, and communicate efficiently, it does not give them the capabilities a computer may give them to apply for job or even learn basic computer skills. Some lower income schools cannot afford updated computers or even Internet access for their students (Goodman, 2013).

The growing gap in the Digital Divide in America and abroad has caught the attention of influential leaders in the technology field, including Facebook founder Mark Zuckerburg, who is on a mission to make Internet access a human right through his Internet.org initiative.

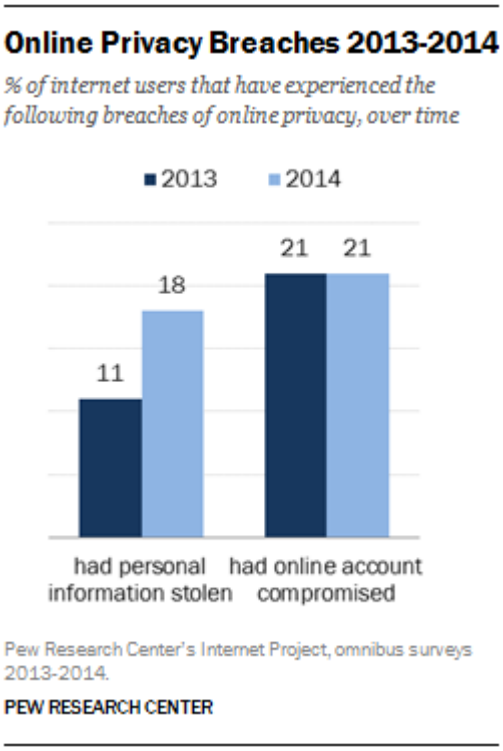
Security and Privacy

In April of 2014, news of an information-hijacking virus dubbed "Heartbleed" instantly brought into focus how the majority of online users view the safety and security of their private information. It was estimated that more than 500,000 individuals had information stolen from some of the most popular

websites and services, including Facebook, Yahoo, YouTube, and Wikipedia. Some security commentators called Heartbleed “catastrophic” and described it as one of the worst vulnerabilities ever discovered on the web (Rainie & Duggan, 2014). Soon after Heartbleed’s discovery, security researchers have estimated that such vulnerabilities could affect up to 66% of active sites on the Internet. And online users are keenly aware of the growing dangers of the amount of personal information available online. Just 33% reported this to be a concern in 2009, however 50% reported it as a concern in 2014 (Madden, 2014).

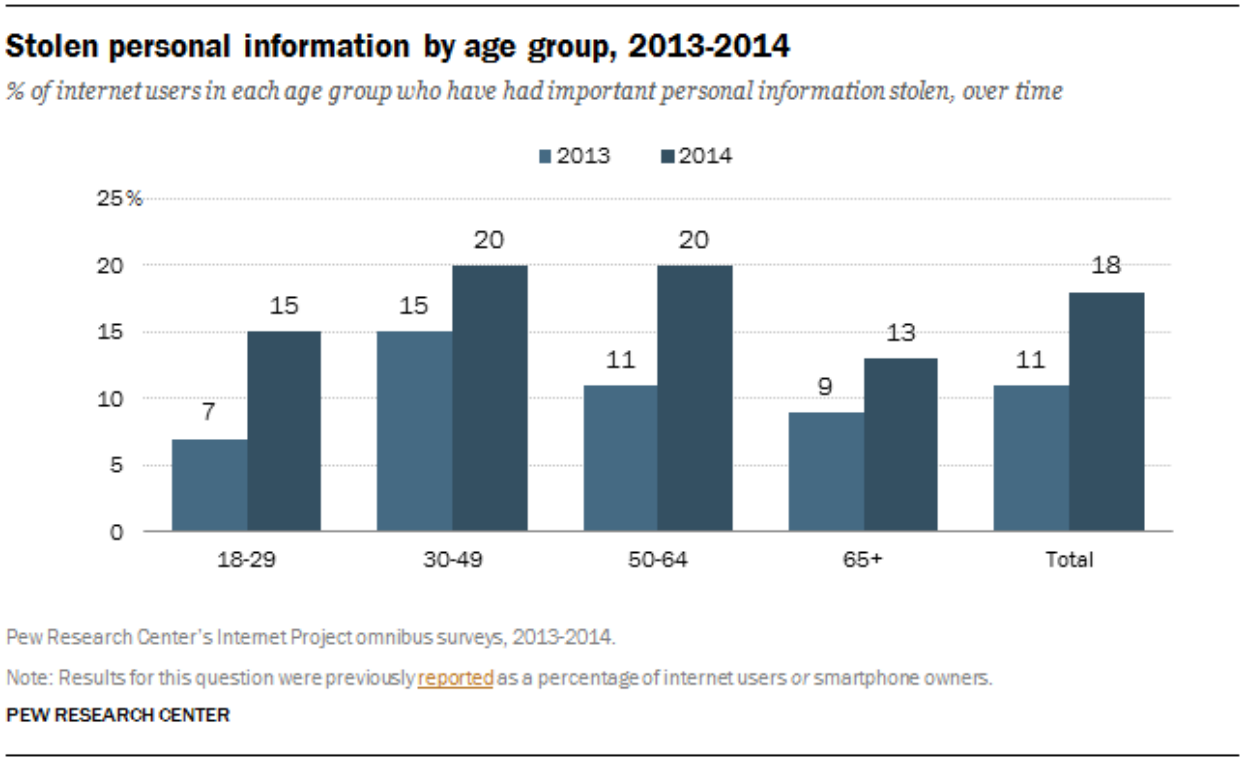
Shortly after Heartbleed was found, the Pew Research Center Internet Project published a report on online privacy and security, finding that 18% of online adults had personal information stolen; an increase of 6% from 2013. Twenty-one percent had an email or social networking account compromised or taken over without their permission in both 2013 and 2014 (Figure 3).

Figure 3.



Age does make a difference when it comes to online security vulnerabilities. In 2014, 30-49 year olds and 50-64 year olds were more likely to have their information stolen (20% for each age group) compared to 15% of 18-29 year olds. Increases of Internet users who had information stolen existed for every age group when 2013 data are compared to 2014 (Figure 4).

Figure 4.



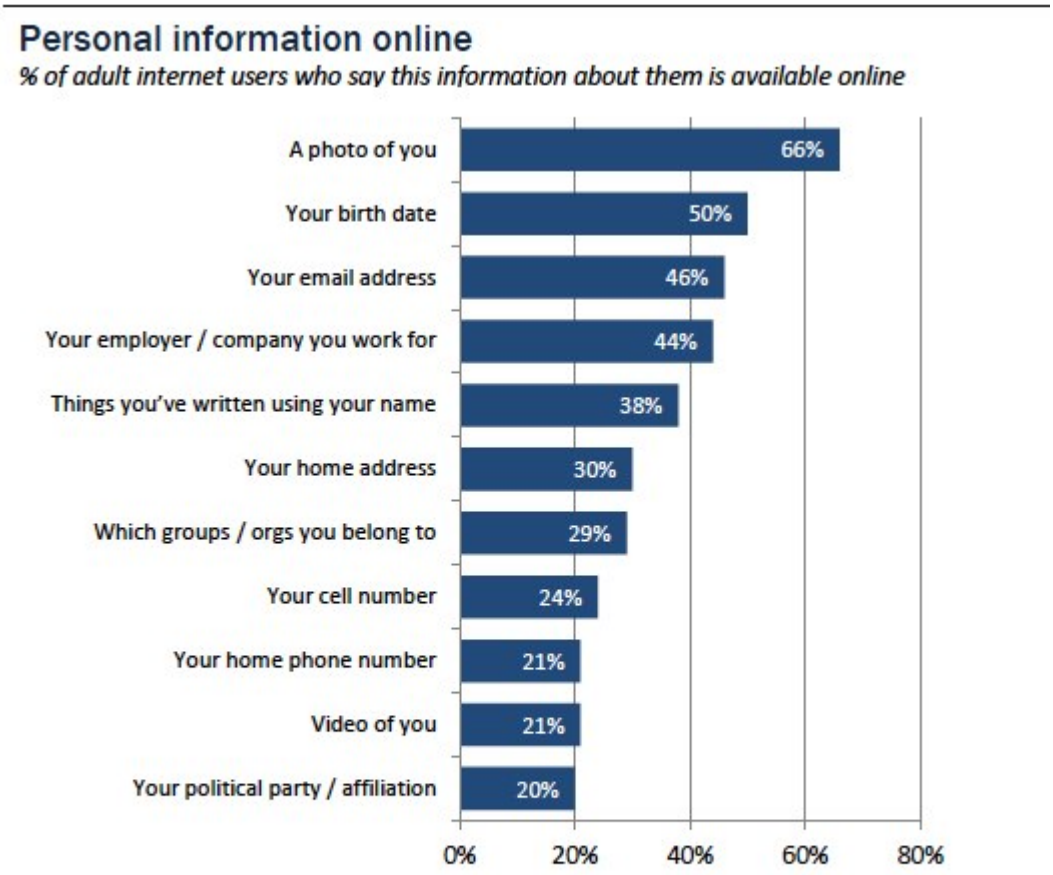
Security and privacy concerns go beyond online environments as technology progresses to include wearable devices such as Google Glass and Apple Watch. In a 2014 study, 72% of Americans surveyed reported privacy concerns as the main reason why they would not purchase or wear Glass (Bell, 2014). Technology utilized since 2010 to enhance security efforts include thumbprint verification. However, as security becomes more of a concern, iris scanning technology (such as Myris) will quickly replace thumbprint verification as a more convenient extra layer of security protection.

In addition to devices, providers of Internet services such as Google have increasingly expanded their online tools and mobile applications to include everything from automatic hotel information on an individual's Google calendar to person tracking via Google Maps. Many individuals are not aware the information they look at online, as well as where they drive on any given day, are continuously tracked through online tools they use. Google admitted in 2010 to obtaining users' login information (including passwords) and emails to garner data for its Street View project. Facebook tracks personal preferences every time an individual engages with their newsfeed. In 2013, while 59% of Internet users did not believe it was possible to be completely anonymous online, 86% had taken steps to minimize the visibility of their "digital footprints" which included clearing browser history (64%) and editing or deleting something they had posted in the past (41%) (Rainie, Kiesler, Kang, & Madden, 2013).

Individuals may be aware of privacy issues when utilizing social media and other online tools, but they are sharing personal information now more than ever before. In the same 2013 study from the Pew

Research Center's Internet Project, 50% of Internet users shared their birth date online and 30% shared their home address. (Figure 5).

Figure 5.



Source: Pew Research Center's Internet & American Life Project Omnibus Survey, conducted July 11-14, 2013, on landline and cell phones. N=792 for internet users and smartphone owners. Interviews were conducted in English on landline and cell phones. The margin of error on the sample is +/- 3.8 percentage points.

Internet of Things

Defined as the interconnection of uniquely identifiable embedded computing devices within the existing Internet infrastructure, the *Internet of Things* (or IoT), is expected to offer advanced connectivity of devices, systems, and services that go beyond machine-to-machine communication. In other words, it's an evolution that will allow objects to interact with other objects. Google Glass and smart watches such as Apple Watch and Pebble are examples of wearable devices that are already mainstream. IoT technology such as the smart systems currently embedded in new cars are another example. Smart systems and GPS mapping in cars are also allowing for driverless capabilities. Google introduced its self-driving car back in 2008, but it has just recently gone mainstream to the public since 2012;

specifically in the San Francisco Bay area (where it is legal to operate autonomous vehicles. And in 2014, Nissan introduced the first self-driving vehicle for personal use in Japan (Weber, 2014).

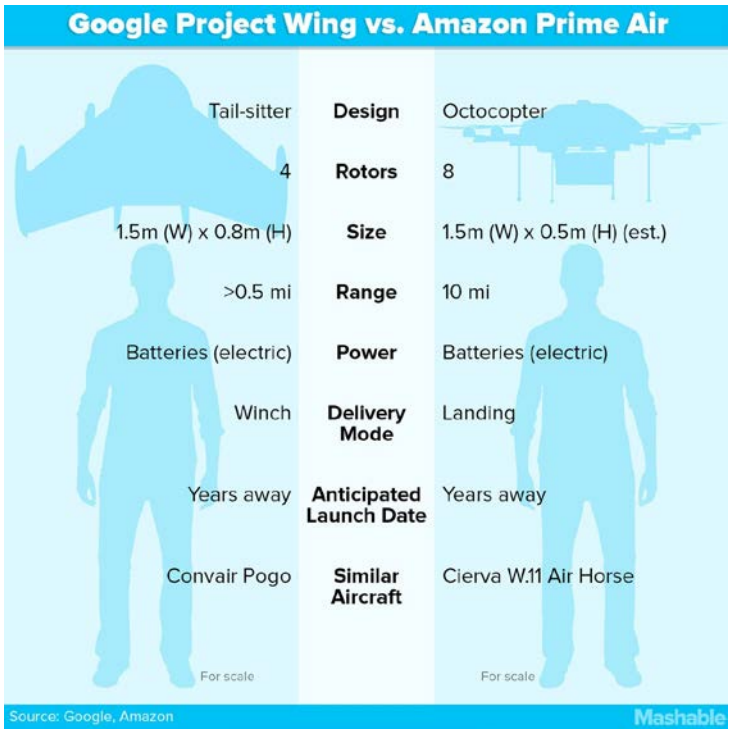
Many other IoT devices exist which are poised to go mainstream but have not yet found the footing. These include gadgets such as earbuds that monitor a user's mood to choose the next song, a responsive bracelet that sends thermoelectric pulses to heat or cool a person's entire body, a hug simulation jacket, and a wireless bracelet that lets users feel each other's touch from long distances. Many of the recent wearable products have been developed with business applications in mind and will most likely improve productivity and organizational efficiency.

Many technology experts say the rise of embedded and wearable computing will bring about the next revolution in digital technology. Eighty-three percent of experts agree that the evolution of the Internet of Things - as billions of devices and accessories are networked - will have widespread and beneficial effects on the everyday lives of the public by 2025 (Anderson & Rainie, 2014). However some of the benefits are already being felt by existing wearable technology;

> *"A sales professional armed with Google Glass will now be able to walk into a sales meeting, look at a client, and retrieve information on his or her industry, job title, and more. Google Glass could instantly display information on the last order placed, past reviews, and the date of the client's last meeting, all in the eyes of the wearer. For those with hands-on jobs, like mechanics and plumbers, Google Glass could become indispensable. If a mechanic needs both hands to fix a machine while reading information usually presented by a tablet or smartphone, they could wear Google Glass to perform their job freely."*
>
> - *Leung, 2014*

In 2014, drone technology is commonplace. Not just for taking amazing POV (*Point of View)* videos of New York City firework displays, drones are being utilized to contribute to big data by serving as an "Internet of Things in the sky". Their potential as such is just beginning to be realized. A drone can capture up to a terabyte of data in one hour. Experts predict more than 7,500 will fly in the sky by 2020, allowing for more large data aggregation than humans can possibly manage. For a comparison, Google's Street View project is one big data example that ushered in a new era. Drones offer similar results, but have "sky view" potential with applications to weather tracking and prediction, 3-D mapping, search and rescue, and wildlife protection (Handwerk, 2013). In 2014, drones were utilized in precision military, farming, and construction practices and were only being introduced to large businesses. Drone use will go far beyond big data aggregation, however, to include convenient front-door delivery services. In the summer of 2014, Amazon's Prime Air Drone delivery service project witnessed the birth of a realistic competitor; Google's Project Wing. If regulatory and logistical issues are resolved, both delivery services will utilize drones within the next several years to deliver purchased products and goods from Amazon and Google (Figure 6.).

Figure 6.



Source: Project Wing vs. Prime Air: Google's Drones Soar Above Amazon's, Pete Sachal

Wireless sensors and devices, applications, and other IoT technologies contribute to big data, which requires "cloud" storage for capturing, analyzing, and responding to all of the information. According to a 2014 IBM trend report, increased reliability on cloud storage will also require an increased demand for education and skills training related to sensor networks, how to implement them and what to do with the data (Chamberlin, 2014).

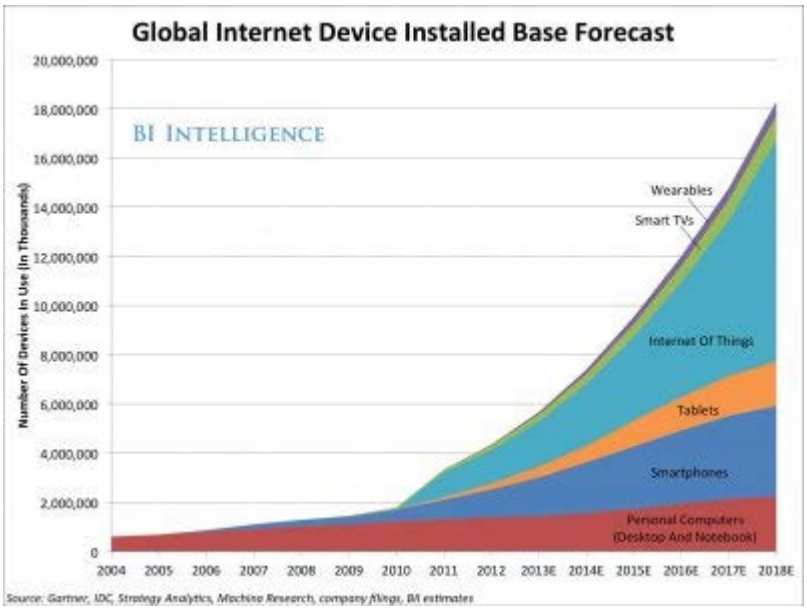
Perhaps the most mystifying gadget that will be utilized as an IoT, is the human brain. Dubbed "the final frontier" by neuroscientists and technology experts alike, large grant funded projects such as President Barack Obama's BRAIN (Brain Research Through Advancing Innovative Neurotechnologies) initiative are advancing the field of neuroscience at an astounding rate. BRAIN and other ongoing projects in 2014 are projected to accomplish for neuroscience what the Human Genome Project accomplished for the field of genetics (White House Press Briefing, 2014). Not only will these research efforts revolutionize the understanding of the human mind and uncover, treat, prevent, and cure brain disorders such as Alzheimer's and autism, it has already assisted in the creation of brain stimulation technology and wearable devices. In 2014, a consumer brain stimulation product called *Thync* allowed users to stimulate their brains for 15 minutes in order to experience increased energy, improved focus, or relaxation. Thync will be available to consumers in 2015. Potential consequences for such products would include an individual giving up their caffeine habit, yoga class, or anxiety medication (Kelly, 2014). Effects from the use of such devices in 2014 were still unknown however, as preliminary studies drew inconclusive results and research in consumer brain stimulation is still in its infancy.

Rapid Change & Information Overload

The pace of technological innovation and change is moving forward at an exponentially rapid pace. In his 1970s book *Future Shock*, Alvin Toffler predicted that the rate of technological change and progress was accelerating at faster than individuals could handle. Alienation of individuals, cracks appearing in the social order, and information overload due to too many choices were all predictions in Toffler's book. Americans are living out many of his predictions today. New computers and mobile devices are obsolete the minute they arrive on a person's doorstep. Americans also struggle with the barrage of information coming at them on a daily basis from emails, text messages, the Internet, social media, etc. And yet the capability of regulatory practices to adapt to changing technology has slowed down. Organizations struggle to implement "best practice" guidelines for utilizing new technologies. Even private businesses are having difficulty keeping up with the best use, consequences, and management of new trends such as big data, the cloud, BYOD ("Bring Your Own Device"), and the Internet of Things (Rossi, 2014).

With the number of projected new technology gadgets numbering in the tens of millions by 2018, Future Shock could continue to grow exponentially as technology grows (Figure 7).

Figure 7.



In 2014, four generations of Americans were simultaneously in the workforce. Signs exist that rapid technological change is already putting stress on individuals who are struggling to adapt. Eventually, experts agree these individuals will be left behind as the rest of the workforce moves forward, again increasing the gap between the "haves" and the "have nots". Toffler posited the only way to bypass Future Shock was to learn to adapt on a constant basis, thus adaptability would be worked into the

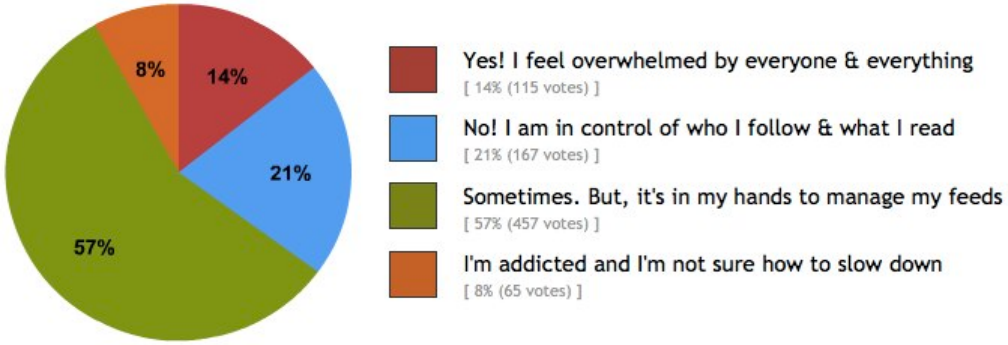
core of every organization's strategy. Businesses such as Proctor & Gamble and Amazon have increasingly relied on futuring and other methods of planning to deal with rapid technological change.

Mobile technology is now at the center of family and social life, much like TVs were in the 1950s and 1960s. Devices that have been designed to increase productivity have also produced unintended consequences. Neuroscientists and psychologists have been studying the effects of rapid, continuous "task-switching" on the human brain many years. A growing body of knowledge suggests an alteration in the brain's attention mechanisms after computer and mobile device use, leading to fractured thinking and lack of focus (Richtel, 2010).

Not all experts agree on the impact of information overload, however. Brian Solis, a digital analyst and futurist, dubbed 2014 as the *Attention Rubicon,* which he defines as the acceptance that our appetite for information has passed the point of no return. Solis, and others, disagree with researchers and experts who claim technological advances are having a negative impact on brain development and functionality. Rather, they point to research that shows the opposite effect to be true. A study conducted in 2009 by working memory expert Dr. Tracy Alloway found that engagement on Facebook had the same positive working memory effects as playing strategy games such as Sodoku (Cockcroft, 2009). Social media sites such as Facebook, Twitter, Google+, Instagram, etc. have been integrated into online users' daily lives, and have also been assumed to be having negative (even addictive) consequences.

Solis posits that our description of information overload can be attributed to society's inability or lack of desire to make order out of chaotic times. He and other experts agree that to be overwhelmed by technology and information is more of a choice, rather than an involuntary consequence. Over time, humans can choose to create filters through which to prioritize the information they wish to see and use. In 2012, Solis created a poll asking social media users *"Do you suffer from information overload because of social media?"* The majority of respondents (57%) reported they sometimes felt overwhelmed, but that it was their responsibility to filter the information they received. Fourteen percent of respondents claimed they felt overwhelmed (Figure 8).

Figure 8.
"Do you suffer from information overload because of social media?



Source: The Fallacy of Information Overload - Brian Solis

It should be noted that just as information overload was a concern with the introduction of the radio and television sets, its possible effect (and even existence) is questionable and will remain to be continuously studied over time. There are many unknowns that do and will continue to exist.

Author Insights - Possible Trends for the Future

There are three possible trends for technology change and adaptation. Probabilities of occurrence are estimations (given the information available and knowing it will likely change) that provide a starting point for conversations about the future. They can be illustrated as: 1) best outcomes possible or trends that go in one direction, 2) the status quo is maintained, and 3) trends go in a different/opposite direction.

A) The Internet of Things, artificial intelligence, and big data make people more aware of their world and their own behavior. Individuals become more knowledgeable about the consequences of their actions, thus change their behavior more quickly and intelligently. Addiction is no longer an issue as humans use brain stimulation devices to overcome unhealthy habits. Augmented reality and wearable devices are closely tied to personal health. Early detection is possible for disease risks, not just disease. Purchases made via wearable devices are delivered to homes by drone delivery services, and include takeout food as well as groceries. Due to a rise in popularity and a decrease in cost, autonomous battery powered vehicles are owned by more Americans and allow for a decrease in vehicle accidents. Traffic jams become a thing of the past, as well as stop lights. Individuals have more free time to work or entertain themselves during transit. Small household robots are created with 3D printers and follow their owners around; akin to household pets. Online security is protected via iris scanning technologies. As broadband and mobile service access gaps close and the Internet becomes an international human right, the nation becomes much more closely connected and collaborative online. Businesses and organizations have adapted to technology change by developing professional development opportunities to help combat Future Shock and information overload. Work teams, whose members are spread across the nation, meet and work virtually on a regular basis as more jobs are located in people's homes and geographic lines (county lines, state lines, national lines) decrease in relevance. Homes are always "online" and connected to various devices, appliances, and gadgets throughout the house. An Internet-enabled revolution in education will spread more opportunities, with less money spent on teachers and infrastructure. ***Based on 2014 trend information, this outcome has an a priori outcome probability of occurrence of .35.***

B) A global, immersive, invisible networked computing environment built with smart sensors, cameras, software, databases, and massive data centers exists in the Internet of Things. Augmented reality enhancements to the real-world input that people perceive through the use of portable, wearable, and implantable devices go mainstream. Drones continue to be utilized to aggregate big data in precision military, farming, and construction practices, but their potential for home delivery services are not realized due to regulatory gridlock and safety concerns. Individuals are automatically connected to the Internet at all times. Being constantly

connected via mobile and broadband services drives up the cost of services. The divide between the “have” and the “have-nots” continues to expand. Pressure is felt by the government to assist in making the Internet and mobile services cheaper and more widely available to the public. A push-pull relationship continues to exist between an open Internet system and governmental regulation standing in the way of significant advancements as online privacy and security continue to be an issue. Individuals begin to change their financial management behavior as online privacy decreases and identity theft increases. Business models established in the 20th century are widely disrupted (most notably impacting finance, entertainment, publishers, and education) with leaders in each industry strategizing reactive efforts in order to cope. Open and online education options increase and student enrollments in both public and private schools significantly decrease. Tagging, databasing, and intelligent analytical mapping of the physical and social realms continue to innovate how people are connected and tracked on a daily basis. Future Shock decreases as Baby Boomers retire and digital natives rise in the ranks of the workforce in leadership and managerial positions. Information overload also decreases as digital natives begin utilizing technologies that filter the information they wish to receive. Businesses and organizations adapt technology policies and professional development opportunities which require staff to learn and use new and proven technologies. Communities of interest continue to grow in social media spaces, allowing individuals to become even more connected and accepting of one another. Autonomous vehicles begin to be used by the public, however not on a large scale due to regulatory gridlock and a large amount of individuals who cannot afford them. Self-driving cars and manually operated cars thus exist side by side on roadways, blocking efforts to overhaul transportation infrastructure and logistics, as well as realize roadway safety potential. ***Based on 2014 trend information, this outcome has an a priori outcome probability of occurrence of .45.***

C) Humans and their organizations do not respond quickly enough to challenges presented by complex networks and opportunities vanish to adapt. Policy and regulation do not match what is needed. Online privacy is eroded and many individuals choose to bypass online access entirely. Only well-off and well-educated individuals afford the luxury of online privacy as businesses begin to charge for security and privacy protection. The divide between the “haves” and the “have-nots” expands to dangerous levels, resulting in resentment and violence. Social media facilitates the sharing of examples and instructions about how to challenge and resist what is seen as unjust. Group-think reaches extreme levels as more uninformed individuals influence others via social media to the detriment of standard of living and effective government. Brain stimulation technology abuse creates new brain diseases. Abuses and abusers evolve and scale. Digital criminal networks will become realities and online terrorism occurs daily. As the world becomes less safe, only personal skills and insights protect individuals. ***Based on 2014 trend information, this outcome has an a priori outcome probability of occurrence of .20.***

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Author(s) & Date

Jamie Seger, Paul Hill, Mark Light, Jerold Thomas

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[1] Along with the research-based data and statistics included in this document, is information provided by the research paper author(s). Although these author insights are not directly cited with research references, they reflect research, observation, logic, intuition, and well-considered expectations compiled by the author(s). The Author Insights sections of this paper are offered for discussion and to help provide a wider perspective for incorporating the descriptor data into the possible future trends. These conclusions are drawn by the author(s) using their knowledge of the scholarly references and their years of professional experience related to the descriptor, and are provided to help the reader more effectively envision the future impact and effects of the descriptor.