West Texas A&M University
Information Technology Whitepaper

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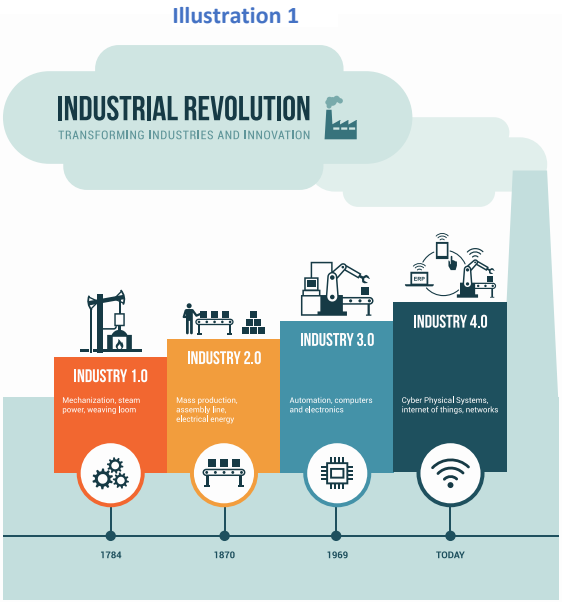
Abstract

Forecasting what technology will be like in the future has proven to be challenging over the years and we often get it wrong, especially when it comes to science and technology. In 1889, Thomas Edison said, "fooling around with alternating current is just a waste of time and nobody will ever use it." [1]. Thomas Watson, the president of IBM in 1943 said, "I think there is a world market for maybe five computers." [2]. And in 1977, Ken Olsen, founder of Digital Equipment Corporation said, "There is no reason anyone would want a computer in their home." [2]. Luckily, we're at a point in history where it's not hard to see that higher education will be confronted by a new generation of students that work, live, learn and play using internet technology.

Today's generation of students will never personally know the link between a pencil and a cassette tape or what it was like to experience the internet through a 9600-baud modem using dial-up-networking and AOL. The internet has become our world. The United Nations has even declared that internet access is a human right [3]. When Facebook first launched in 2004, who could have ever imaged that it would connect more than 1 billion people across the globe. If Facebook were a country, it would likely be the third largest country in the world. Of course, it wouldn't have happened without alternating current, computers, mobile phones or the internet.

The industrial revolution (Illustration 1) sparked a wave of innovation that transformed our world. From the steam engine and automobile to radio communications, we are living in times of exponential change fueled by rapid advancements in technology and the internet, which just keeps getting faster and more ubiquitous. Industry 4.0 brought about disruptive innovation, cloud, the internet of things (IoT), and artificial intelligence, which will demand a new way of thinking. West Texas A&M University will need to develop an understanding of these concepts and begin to incorporate these technologies into classrooms, online learning platforms, mobile apps, the library, the business office, financial aid, and all across the campus where student services could be augmented with automation, artificial intelligence, virtual reality, and a deep level of personalization.

Illustration 1



Disruptive Innovation

The Time magazine person of the year in 2006 wasn't a former president, a famous author or even a Nobel peace laureate, it was you. The cover page simply showed the word you within a video player and a caption that read, "*Yes, you. You control the information age. Welcome to your world*." The rise of internet video and social media has given everyone equal footing and the means to establish their own personal brand, for free. Everyone is now their own technology company and the internet has enabled a new generation of global entrepreneurs that are not bound by traditional barriers to entry. They think differently.

Google, the number one search engine on the planet already processes billions of searches per day and recently confirmed that approximately 15 percent of searches have never been seen before [4]. YouTube, the second most popular search engine, whose mission is to give everyone a voice and show them the world, now has more than one billion followers. Over 8 million of those followers subscribe to Casey Neistat's channel, a popular YouTuber that has effectively leveraged internet video and social media and encourages others to follow their dreams and, "Do What You Can't. His message is that we are the makers, the directors and creators of this generation, which is what Time was getting at 11 years ago.

Disruptive innovation, first coined and explained by Clayton Christensen, has been happening for years and is described as an innovative process that leads to the creation of a newer, more affordable product or market that displaces incumbents that have long enjoyed their market share. New companies that think digital like Airbnb, Zappos, Zenni Optical and Uber are a few that come to mind that have disrupted well established markets all the way from hotel chains and prescription eye glasses to public transportation. Will higher education be the next industry to be disrupted?

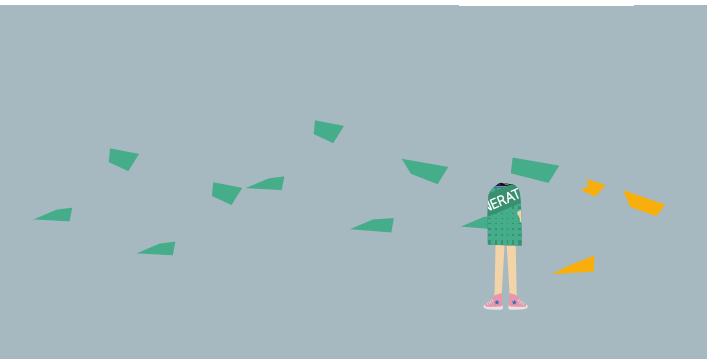
Consider two companies; Kodak and Instagram. Kodak, once considered a household name, was founded in 1888 and by 1998 had announced plans to lay off 16,000 employees and take a $1.5B charge against earnings [5]. By 2012 the company had filed for bankruptcy protection, the same year that a two-year-old startup was being sold to Facebook for $1B [6]. Here was a startup company that was worth $1B after just two short years, a feat that took a bellwether company trading on the stock exchange decades to achieve. What went wrong? They failed to recognize the transition to digital. [3] Richard Foster from Yale University recently states that the average lifespan of a company listed in the S&P 500 has decreased from 67 years in the 1920's to only 15 years today [7]. A recent study conducted by Washington University predicts that 40

percent of fortune 500 companies will disappear over the next ten years [8].
Every industry will be affected by this type of disruption, especially higher education. Institutions of higher education compete for students, plain and simple. Disruptive innovation, and the changing generation of students is going to have a profound impact on an institution's ability to engage, recruit and retain students.

Generation Alpha

The focus has long been on Gen Y, and more recently Gen Z, digital natives who are considered by many to be tech savvy individuals that can multitask across more than one screen. But what about the next generation of students that were born after 2010. They will be on our campus as we approach the 2027-28 academic year. Generation Alpha (Illustration 2), as they are known, are the kids that have only ever known touch screen gadgets, pervasive internet access, swiping motions, haptic feedback, artificial intelligence, voice recognition, and virtual reality.

Illustration 2



According to Joe Nellis at Cranford University in the UK, the fundamental characteristic of Generation Alphas will be their relationship with information technology [9]. They will be the wealthiest, most educated and technological savvy generation that we have ever known. Generation Alpha will interact with artificially intelligent devices starting with the Internet of Toys, where everything is hyper-connected and the physical world is blended with the digital world. Need an example? Hologram Barbie, a digitally connected, virtual reality doll, will make her debut in 2018 and be able to check the weather, play music, set reminders, throw a dance party, and change her wardrobe at a moment's notice to accommodate the current mood and desire of the child, which will no doubt set high expectations for other products and services in every industry. Lego is another great example who has embraced technology and social media to stay relevant.

[1] Andrew Stephens, associate dean of research at the University of Oxford said that if brands wish to remain relevant and appealing to the next generation, they must stay on top of emerging technologies [10]. Technologies such as augmented reality, which is already being used by Pokémon Go and social media giant Snapchat. As Generation Alpha grows up, they will seek out brands that leverage technologies like augmented and virtual reality when purchasing a vehicle, shopping for clothing, going to the doctor, and even apply this as a standard for researching and deciding upon a college.

Key Insight: Karen Gross, author of Breakaway Learners and former policy advisor to the U.S. Department of Education, says that Universities need to start thinking several steps ahead and realize that technology will be more profound in terms of socio-economic penetration and how education happened in the past is not how it will happen in the future [11].

The Internet and Information Technology

It is impossible to spell the word University without IT. From the internet routers to the labyrinth of Ethernet cables and network systems that enable a student to enroll in classes, submit their course assignments and communicate with their professors, information technology has become the digital fabric that enables the processing of modern-day workloads and binds the University together.

When West Texas A&M University first established its telecommunications network in 1966, the same year that Star Trek first aired on television and offered a glimpse of futuristic communication gadgets, voice recognition technology and handheld computers, it was clear that distributed network systems would usher in the fourth industrial revolution. The fourth industrial revolution or industry 4.0, is unlike the timelines of the previous three, appears to be non-linear, is happening at an exponential rate and has brought about disruptive innovation. Science fiction has become reality and Gene Roddenberry's futuristic television series that aired 51 years ago accurately predicted the future.

By 1969, we were already in the third industrial revolution and had programmable logic logical controllers, computers, data processing equipment, and hard disks. By 1987, just 18 years after the start of the third industrial revolution, WTAMU had over 400 computer terminals on the network connecting to a central processing computer system known as the PRIME that had an astonishing 4 megabytes of memory and 2 gigabytes of disk storage and cost just over $100k. Think of how much that technology would cost today through Amazon or eBay or how much power the iPhone has. The cost of technology was not only getting to be more affordable, but it was getting smaller and faster.
Since 2005, the University's internet bandwidth has increased by 1,250 percent annually and today, the campus has 4 gigabytes of bandwidth through multiple internet service providers. Faculty, staff and students download more than 6 terabytes of data each day, which is the equivalent to 1.9 million digital photos, or 107,000 hours of music, or 3,150 hours of video. That number will increase given the recent bump in bandwidth and wireless connectivity.

Teaching and learning are no longer confined to the classroom and a connected campus provides a better, more efficient faculty delivery and a richer, more engaging student experience. Every class in the University's catalog now has an online component, even student evaluations are now delivered through the cloud. Today, WTClass connects students in fourteen different countries across the globe and twenty different states in North America.

The Cloud

For higher education, the cloud has created an ecosystem of partners. It will become increasingly important to invest in the infrastructure that provides reliable and secure connectivity across multiple paths and multiple service providers to provide redundancy. Modern day data centers are leveraging the cloud to provide failover capabilities and vendors like VMware and Amazon Web Services are working together to create software-defined-data centers that can be migrated from the east cost to the west coast or across the Atlantic to London. There will be ramifications related to cyber security, but there is no question that the cloud is becoming the new global network aggregation point for many organizations and creating innovative and transformative products and services, that Generation Alpha will no doubt demand.

According to Gartner, software investments by top vendors will shift from a cloud first philosophy to one that is cloud only and expenditures in cloud will impact organizational spending by $1 trillion [12]. Learning management systems like Blackboard are primarily hosted in the cloud today and newly developed learning platforms such as Canvas are cloud only. Software subscriptions to online educational technology products already account for a large portion of the IT budget and spending on local applications and systems is declining. Microsoft recently hinted that they will likely not invest in developing on premise email and calendaring systems beyond 2020 as their Office 365 product grows in popularity. The University's email infrastructure will likely be hosted in the cloud in just a few years and leverage the capabilities of Microsoft Office 365, which also means that without an internet connection, you will not be able to access messages, which could be stored anywhere on the planet in one of Microsoft's data centers.

Cloud-based digital assistants available on smartphones, tablets, and even desktop operating systems are already becoming the interface into our homes and daily lives. The doorbell, the washer and dryer, heating and air, lighting and garage door openers are already connected to the internet and can be remote controlled from anywhere. The smart connected home is changing the way we interact with our appliances. A new camera and mobile app was recently unveiled that allows you to remotely look inside

your refrigerator, so if you're at the grocery store and can't remember if you're low on milk or eggs, no problem [13].

Personal digitals assistants like Alexa, Siri, Cortana, and Google Home are all powered by the cloud and will soon be the primary way that we access the internet instead of using a personal computer or a laptop. If This Then That (IFTTT) is a popular website that was established in 2010 that enables apps and devices to work together in creative new ways to enable home automation by combing different IoT components.

Key Idea: The University should adopt a partly cloudy approach over the next several years, carefully reviewing partner contracts to ensure compliance, choosing vendors carefully, and ramp up cloud-based technologies more aggressively.

The Internet of Things

The internet of things is an internetwork of physical objects or things that leverage wireless, sensors, and embedded technology to monitor the conditions or state of physical objects and exchange information for insights. For example, the Union Pacific Railroad has been using IoT sensors along train tracks since 2012 and has reduced derailments by 75 percent by placing these systems in key locations to detect bearing malfunctions [14]. The NFL recently started using sensors placed within player's shoulder pads to monitor location on the field, track player's running speed, acceleration, and the total distance traveled, which will be used to populate data for video games and other analytical purposes [15]. Although IoT is a relatively new term, it is already beginning to transform our campus and create exciting learning opportunities for faculty, students, and researchers.

According to Gartner, there are now more than 8.4 billion devices connected to the internet and that number is expected to increase by more than 21 million over the next several years [16]. For the past 38 years, the number of devices connected to West Texas A&M University's network has grown from 60 connected devices to more than 5,000 connected devices, representing an 8,233 percent increase in connectivity. By 2035, that number is expected to increase to more than 20,000 devices across the campus that will include a wide array of IoT sensors, outdoor computing devices powered by solar, and data acquisition networks that will lead to the creation and expansion of new academic programs, advance faculty research through STEM, and provide experiential learning opportunities for the students across the Texas Panhandle.

One such example can be found through the Cooperative Research, Education, and Extension Team (CREET), which was formed early on between West Texas A&M University, Texas A&M Agrilife Research and the United States Department of Agriculture. Researchers in the Texas Panhandle are using advanced IoT sensors to develop water irrigation management techniques that optimize water usage and improve crop yields through data analytics, advanced measurements, stress indicators and other yield predictors. The School of Computer Science and Engineering has been building IoT air quality sensors using open source technology for Texas A&M Agrilife Research in Amarillo to measure background concentrations of gases, particles, and bioaerosols at feed yards and most recently, a smart-connected parking lot was developed by IT and students in CIDM 3385 using open-source computer vision and advanced machine learning algorithms to display real time parking lot availability as part of a pilot project to improve visibility into campus parking.

According to IDC, spending related to the IoT will reach $1.7T in 2020 [17]. Simona Jankowski from Goldman Sachs global investment research group predicted that a company's ability to adapt and thrive in this new era of the internet of things is very likely to determine who the next set of winners and laggards will be in this digital age [18]

Key Idea: The University will need to strategically invest in IoT technology and establish a dedicated network that uses technologies like LoRaWAN, low power long range wide area networking, which will enable the blending of the physical campus with the digital campus.

Current State of Information Technology

The University maintains a vast fiber optic network that connects every building on campus, including the Panhandle Plains Historical Museum, the Amarillo Center, the Enterprise Network and the Small Business Development Center. There are approximately 300 network aggregation switches, 1,000 wireless access points, 800 video surveillance cameras, and more than 2,000 telecommunication devices that serve the campus. That number will significantly increase as IoT networks are created and security controls will expand from the network to edges of the campus that connect these sensors and monitors.

As of today, almost 300 servers have been virtualized, a technology that enables multiple applications and databases to run virtually in software across a single physical server, which has reduced overall power consumption and created standardization and

optimized maintenance and operations. It has also created an economy of scale that has been leveraged to build the necessary private cloud infrastructure that provides advantages to the University, such as the agility to respond to the needs of the campus. The time to deploy a server has been reduced from several weeks to several hours and disaster recovery and business continuity of mission critical systems data has been optimized and can be recovered within eight hours.

The priority has been to enhance student engagement by creating a connected campus that enables next-generation communications, teaching, learning, and information security. The University's connected campus provides a 21st century framework that integrates online learning, video collaboration, and lecture capture systems to support hybrid learning to enhance the overall learning experience for today's generation of learners. The IT mission to transform the educational experience through innovation, technology, and customer service excellence will be guided by six fundamental principles:

1. Maintain a connected campus that enables next-generation teaching, learning, and communications.
2. The centralization of technical and financial resources.
3. Alignment of information technology's processes and services to more effectively support the mission and objectives of the University.
4. The operation of a public, private cloud infrastructure that provides flexible, cost-effective, and scalable services for a multi-campus environment.
5. A shared vision that is consistent with the University's vision, mission, and goals.
6. Alignment of technology projects and initiatives with institutional priorities.

Improving Student Outcomes Using Information Technology

The Educause Center for Applied Research (ECAR), a research organization dedicated to understanding information technology's role in colleges and universities, has recently published its latest findings in their 2017 report that included 43,559 students from 124 different institutions in 10 countries. One of the key takeaways is that students prefer a blended learning environment that includes some online components due to the modality by which they learn [19].

Research data indicates that blended learning environments that offer at least 25 percent of the content online lead to more significant gains in students' ability to learn [19]. This will only become more pronounced with Generation Alpha, who are growing up in a physical world that is blended with digital across many aspects of their daily life. One of the strategies recommended by Educause is to begin to partner more closely

with instructional designers to develop a student-centered pedagogy and increase digital learning opportunities [19].

Key Insights: Recommendations for institutions of higher education from the most recent ECAR report include the following strategies and action items, which will serve as the building blocks for the digital architecture of tomorrow.

1. Seize upon student enthusiasm for digital student success tools and partner with institutional stakeholders to build institutional support services around them. When student success tools are integrated into larger student success initiatives that coordinate campus resources, the digital tools for student success can only be more impactful, especially for groups that are traditionally disadvantaged [19].
2. Begin laying the foundation for the development and adoption of next-generation digital learning environments (NGDLEs). On the technical side, NGDLEs that feature interoperability, personalization, collaboration, accessibility and universal design, and analytics require the development of APIs and open standards that can harness and integrate student success and learning analytics. On the cultural side, investment in faculty training and coaching to better use existing LMS features now will improve the learning experiences of current students, build buy-in for online teaching and learning opportunities, and prepare faculty and students to use and thrive in the NGDLE [19].
3. Create faculty development opportunities to help instructors understand how students are and are not using personal computing devices and develop ways in which they can be leveraged in service to student learning outcomes. The importance of student devices to their academic success is considerable. Helping faculty learn how to augment assignments that harness students' individual computing power could significantly improve student learning and engagement. Developing faculty communities of practice around teaching with technology can provide both excellent examples and a network of support when experimenting [19].
4. Evaluate the reach and utility of campus technology help desk services to students and make an effort to understand why such services might be underused. Depending on what one finds, a range of solutions might present themselves including, expanding hours, reducing ticket turnaround times, curating excellent DIY examples, and making help desk services more visible and available [19].
5. Institutions should monitor the loads on their wireless bandwidth, especially in the dormitories, and the coverage of Wi-Fi in outdoor spaces, making upgrades as appropriate. Wireless coverage and reliability are rated highest in the formal academic spaces of campus but may be lacking in the informal learning spaces where students spend the majority of their time studying, playing, and living [19].

Insights for Faculty and Staff

The University of Hawaii recently published a guidebook for teaching and interacting with new generation of students and recognized that it must change its way of teaching to adapt to the learning styles and teaching methods of future generations [20]. The compendium details how this new generation of students is different from previous generations through a helpful article titled, "A Tsunami of Leaders Called Generation Z" published by Dr. Darla Rothman [21].

Key Insights: The research article detailed the following characteristics about these students:

- They have never known a world without internet, cell phones, or iPods.
- They are tech savvy and in constant contact with people 24/7 using Facebook or Twitter.
- They want technology that is easy to use and will solve their problems, help coordinate their activities, or provide them with relevant people or information.
- Their brains are affected by internet use. They find answers to questions in Google and YouTube, but they lack the critical thinking skills to evaluate sources.
- They have low/no tolerance for being without digital resources.
- They have never had to use a library card catalog or rummage through shelves to find a specific book.
- They don't use wristwatches or alarm clocks because they use their smartphones for that.
- Instead of reading articles, they want to watch a video (YouTube) that summarizes it.
- They may never send an email: [that is "so yesterday"]. Why email when you can text, instant message, tweet or Facebook?

According to Dr. Rothman, "some research has shown that the brains of Generation Z are structurally different than those of earlier generations. This has nothing to do with genetics and everything to do with how we use our brains to respond to things in our environment. The brains of Generation Zs have become wired to sophisticated, complex visual imagery. As a result, the part of the brain responsible for visual ability is far more developed, making visual forms of learning more effective. Auditory learning (lecture and discussion) is very strongly disliked by this age group. Interactive games, collaborative projects, advance

organizers, challenges, and anything that they can try and see are appreciated" [21].

It's no surprise then that the ECAR report highlighted that lecture capture was the number one technology that students wished instructors would use more and would lead to better learning outcomes. According to Dr. James McQuivey of Forrester Research, a minute of video is worth 1.8 million words [22]. Cisco's visual networking index predicts that globally, video traffic will be 82 percent of all consumer internet traffic by 2021, up from 73 percent in 2016 and that it would take an individual 5 million years to watch the amount of video that will cross global IP networks each month in 2021 [23].

Conclusion

Part of the University's mission statement is to provide a technology rich education to students and that means something entirely different than just a few years ago. The changing generation of students will force higher education to rethink traditional delivery models and embrace innovation and technology. These students think and learn differently, spend 9 hours a day on their devices [24], and have never known a world without the internet, iPads, or social networking, which is now the modern-day cul-de-sac.

2018 is here and these technologies are reality today and by the time that Generation Alpha begins their postsecondary education, they will have already experienced a completely different educational model. Students demand a technology-rich education and they will vote with their tuition dollars as to which institution of higher education they attend. Will we be ready for this generation?

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