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DISCUSSION

The Education of the 21st Century Professional

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Abstract: Since the inception of computational technologies in the 1940s, astonishing digital technological progress is transforming everything. Society has experienced a revolution in the acquisition, processing, and communication of digital information. Technological improvements have transformed early large machines into compact devices that enable, mediate, support, and organize our lives. The Internet and the web, new multi-modal, mobile connecting devices, and the cloud, in combination, are having a far greater impact and adoption speed than any previous technology; and these digital technologies will continue to accelerate.

This paper highlights the importance of combining liberal arts skills with digital fluency in the education of the 21st-century professional. This is the single most important aspect that will identify a person as "literate" in the century of information. The transformative experience of the liberal arts has traditionally led to successes across many different fields and it stands to make an even greater impact in the information economy. The core practices that have made liberal arts education so successful over the centuries cannot be replaced by technology. Instead, liberal arts education will interlock perfectly and reciprocally with continued technological advancements. This ***is*** the essence of what we are trying to accomplish at Keuka College. In this paper, we present a brief summary of technology evolution and its implications for the labor market, and introduce Keuka College's initiative for educating professionals in the globally connected digital world of the 21st century.

Keywords: 21st century education, computational thinking, digital learning, workforce development, Industry 4.0.

1. Introduction

The information revolution has transformed the world and all aspects of our daily lives, touching every human endeavor, through ubiquitous access to information, increased automation, and pervasive human networking; and it is drastically changing both the economy and the nature of work worldwide.

All of this is happening at a very fast pace, faster than anything we have seen before. It took roughly 40 years from the 1940s to the 1980s—see Figure 1—to replace the ***one computer many users*** concept of the (1) *central*

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computer or mainframe by the ***one computer one user*** that was enabled by the development of the (2) *personal computer*.

In less than 20 years, (3) *smart phones and cards* appeared, followed very quickly by ubiquitous (4) *embedded computers* and (5) *intelligent environments* that allow the ***many computers one user*** paradigm in which we live today.

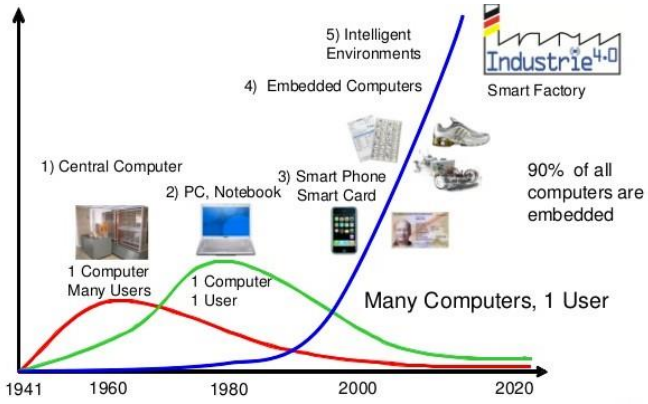

Figure 1. Digital evolution.

The speed of technological change is becoming exponential (see Figure 2 adapted from [1]) and digital technologies will continue to accelerate and we will continue to witness an increase in the number, shapes, and sizes of digital devices, as well as an exponential increase in local and global connectivity. The First Industrial Revolution, in the 1780s, used water and steam power to mechanize production; it took thousands of years to replace the agricultural revolution (not shown in the figure). The second industrial revolution, 100 years later, used electric power to create mass production and the combustion engine to create mobility. The third industrial revolution, 70 years later around 1940-50, used electronics and rudimentary information processing machines to automate the office and factory production, and from the 1980s on this progress has accelerated rapidly.

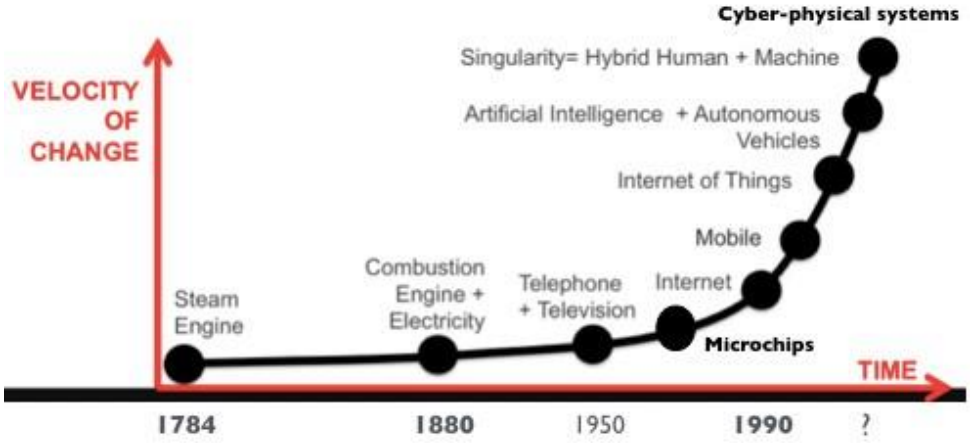

Figure 2. The Speed of Technological Change.

Now, a fourth industrial (hyper-digital) revolution, so-called Industry 4.0, is building on the third, the digital revolution, that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres, i.e., *cyber-physical systems.*

This hyper-digital revolution has led to unprecedented emergent businesses, and behavioral and industrial intelligence, giving birth to the information economy. We live in a world in which information and ideas "establish economic value chains and encourage further technological innovation and diffusion of knowledge."[2] We live in a data-driven world where information is our lifeblood. Society as a whole is increasingly dependent on digital technologies providing unprecedented access to information, and hereto unimaginable capabilities for manipulating this information for the advancement of every industry.

Digitization is revolutionizing every field: music and media, finance and publishing, retailing, distribution, services, manufacturing, etc. In almost every industry, technological progress is bringing unprecedented bounty, driving reallocation of wealth and income, superseding the industrial economy of the past two-and-a-half centuries, by far. Several industries have been shaken to their core, driving some companies out of business [3].

All this is possible because ***digital technology is the most general purpose technology there is***, even more so than electricity and steam power. Digital technologies can be successfully applied virtually in any domain, thus affecting all sectors of the economy. Their combinatorial application explodes quickly, creating infinite possibilities for recombining existing ideas into new ones, which in turn can be combined with new ideas, and so on and so forth.

Digital technologies change rapidly, but organizations and people's skills aren't keeping pace. As a result, millions of people are being left behind as more and more jobs are becoming automated with advanced technologies, while other jobs are requiring digital fluency and competency. ***Unless individuals can transcend technology within their professional context, they will be replaced by it***. This is an important point with enormous implications for higher education, making it imperative to rethink higher education in the 21st century.

2. Impact on the workforce

The jobs of the future belong to those who are more than just critical thinkers, that is, they belong to digital thinkers. The world of work is changing dramatically in the information economy and people need to be prepared for jobs requiring digital capability. It is predicted that in the not too distant future, half of today's jobs will change or disappear altogether. According to research at Gartner, one-third of all jobs will be converted into software, robots, and smart machines by as early as 2025 [4].

Technological advances diminish the demand for previously important types of labor, resulting in increased demand for more skilled labor while decreasing demand for less skilled labor. Non-routine cognitive jobs and non-routine manual jobs (e.g., hairdresser) will be increasing, providing more opportunities for creative and interactive work. Repetitive tasks that can be automated will disappear and future jobs that do not exist yet will be available.

An Australian agency recently reported that "60 percent of Australian students are training for jobs that will not exist in the future or will be transformed by automation," indicating that 44 percent of jobs will be automated in the next 10 years [5]. Backing up this statement, a 2013 study by Oxford University predicted that 47 percent of today's jobs will be automated in the next two decades [6]. Davidson [7] projected that 65 percent of U.S. students in K-12 schools today will work in jobs that do not currently exist.

In the future, people will probably be paid depending on how well they work with machines. "Marc Andreessen, the co-creator of the Netscape web browser, likes to say, in the future there will be two kinds of jobs: those that involve telling computers what to do, and those that involve being told what to do by computers." [8]

In the U.S., it is projected that at least 50 percent of STEM (Science Technology Engineering and Mathematics) jobs will involve digital fluency [9]. Over the past ten years, technology occupations have grown by more than 20 percent and are projected to continue growing at a similar rate through 2020 and beyond [1 0]; they are among the fastest-growing and highest- paying jobs across the U.S. However, computer science and engineering graduates, as well as those from information systems and technology programs, fill just 40 percent of the available positions each year, and by the end of the decade, it is projected there will be a 1 million shortfall of qualified "digital experts" (see Table 1).

Table 1. Digital Experts Job Gap

• 144,500 new jobs for people with computer-related degrees each year
• 57,000 new IT/CS bachelor's or master degree graduates each year
• 87,500 unfilled technology jobs each year

The demand is clear. Even if we could substantially increase the number of computing programs in colleges and universities, the gap between the demand for computing-proficient professionals and the number of prepared graduates would continue to widen; *there are simply not enough computing graduates, and there are not likely to be, to satisfy the ever increasing demand for talent*. What's more, as technology development keeps changing—a trend that has accelerated in the past couple of decades—retraining of digital experts will always be needed.

The need is so great that coding training companies are mushrooming throughout the United States to try to fill this gap [11] by 'retraining' graduates from nontechnical disciplines. These for-profit, non-accredited programs have been cropping up in response to a swelling market demand and are operating without much regulation. CNBC recently reported that "For many prospective students [in the United States] looking for a quick route to a six-figure salary at a big tech firm, *coding camps* have become attractive alternatives to colleges and grad schools." [12]

Coding camps vary in quality, but most bootcamps promise steady, high-paying work upon graduation, prompting aspiring coders to invest anywhere from $10,000 to $20,000 to enroll in 10-12 week intensive courses. There is even a company that will pay you, instead of charging you tuition, to attend a 10-week bootcamp after which they will place you in a well- paying job (they make money by charging a "finders' fee" to the employers). Coding bootcamp enrollment has increased by 138 percent from 2014 to 2015, compared to more modest growth in traditional computer science degrees of 14 percent from 2013 to 2014 [13].

We are at an inflection point in history. Given the hyper-digital revolution, how should educators respond to this accelerating change? We obviously need an alternative approach. We simply cannot take on 21st century tasks with 20th century tools and expect to be successful. The question then becomes: ***Are we preparing our graduates to join the workforce of the information economy?***

3. Digital fluency is key

The 21st century professional needs to understand today's society in a digitally connected world where the effective design, implementation, and use of information and digital technology are driving career opportunities.

A universal problem for every citizen of this century is how to get access to information and how to acquire skills to articulate and organize that information to solve today's problems effectively in the course of their professions. Although the computer revolution has brought substantial changes to the way we live, the population at large does not completely understand, for the most part, the real impact of this revolution, and what's more, it cannot begin to imagine the possibilities and what is yet to come. Indeed, a large portion of the world's population uses computers for everyday tasks, but most fail to benefit from the power of computation. They are limited to being passive consumers because they don't understand computers' technical underpinnings.

People often perform repetitive actions manually because they are not able to use the uniquely powerful features of digital devices via ***programming***. If you know how to program, computer-related tasks that used to take weeks to finish can take only a few hours. There is likely no other skill that leads to an instant 10x productivity boost. People can work ten times faster by writing computer programs to automate tedious tasks that they would otherwise need to do repetitively by hand. Programming allows you to discover more creative solutions, and by doing so, you're more likely to come up with innovative solutions.

There is a common misconception that to work with information and digital technology you have to major in computer science or information systems or similar programs. But it is no longer the case that computers are so mysterious that only specialists can understand what they are capable of doing or not doing.

We contend that digital technology is no longer the purview of only computer scientists and engineers, and digital creations are no longer just the realm of specialists. We further submit that the vast majority of people who will make effective use of information to solve problems in today's society will not be computer scientists or engineers, but professionals in any discipline armed with a working knowledge of digital technologies.

Computing professionals are general-purpose problem solvers and their skills can be applied virtually everywhere—look at how far the world has come and how much everyday life has changed thanks to their skills. When technical people partner with those trained in the liberal arts, world-changing innovation happens. What if these liberal arts-educated professionals were "fluent" in the technologies that are making everything move in this information economy? As Steve Jobs put it: "It is in Apple's DNA that technology alone is not enough— it's technology married with liberal arts, married with the humanities, that yields us the results that make our heart sing." [14]

In the near future, most professionals will write code at some point in their careers—for example, using relatively simple macro languages [15] available for many applications. In fact, many people today program not as a career but as a means to an end. These "end-user programmers" are people who use a computer as part of their daily life or daily work, but who are not computer professionals. The number of end-user programmers in the U.S. alone is estimated at more than 11 million—compare this to only 2.75 million professional programmers.

It is not difficult to learn to code, particularly if you have a logical turn of mind. Knowing how to program allows you to communicate effectively with professional programmers who do the heavy-lifting coding. We don't expect you to become as adept as the professionals, but the more you know about programming, the more you will be able to relate to them and to command their respect. If

you can motivate professional programmers to spend more of their time helping you solve technical problems, you can work 100 times faster than if you had to attack those problems alone.

Michael Staton [16] captured this idea well: "Many liberal arts colleges require a foreign language—not because they believe their history majors will land jobs in France or Mexico, and not because they are being trained as translators, but because they believe the skills learned in a new language create global citizens who are open to and comfortable with interacting in a multicultural, multilingual world. It's the same with the above skills [digital]. They need to be understood not as a way to turn philosophy majors into geeks, but as a way to tell the world that a philosophy major can be open to and comfortable with, daresay even take advantage of and thrive in, a technologically changing world."

While specialists in computing will always be needed, our goal is not for everyone to become a professional programmer. Our position is that ***everyone needs greater digital fluency***; it is essential that everyone understand the intellectual and human meaning of what digital technology is all about. Everyone should develop a base digital acumen so as to make sure technology is doing the best it can for them.

4. The liberal arts advantage

Looking at these factors, the inescapable conclusion is that the benefits of digital technology depend on what you make of it: ***it's up to you to leverage digital technologies in the best possible way.*** What we need is an interdisciplinary approach across the board for educating the new 21st century professional, and to do so requires understanding of digital technologies and, most importantly, knowing how best to apply them to your specialty's skill set. We envision a new kind of professional who will control the future of information within the context of their specific specialties. This requires ***all*** professionals knowing something about digital technologies, especially within the context of their discipline, by adding digital fluency interwoven throughout the entirety of the educational experience. That is to say, we need a broad-minded, cross-functional and digital-capable professional, a ***neo-generalist,*** formed by mixing together basic sciences and math, the humanities and design, expertise in a professional discipline, **and** digital technology.

Individuals must have a combination of a strong technical education with communication, ethics, and critical thinking skills. We believe that the combination of liberal arts skills— such as working productively in teams, critically thinking, and effectively communicating to solve complex problems—plus digital skills is the single most important aspect that will identify a person as "literate" in this century. Combining liberal arts with methods fromdomains such as analytics, statistics, and coding provides students with a more expansive skill set that integrates both broad-based concepts and technical, quantitative content, leading to the deeper learning of each.

Scott Hartley, a leading venture capitalist offering surprising revelations on who will drive innovation in the years to come, in his recent book [17], beautifully and convincingly makes the case for the liberal arts in the digital world, "*Our technology ought to augment rather than replace, and ought to provide us with great hope rather than fear. Finding solutions to our greatest problems requires an understanding of human context as well as of code; it requires both ethics and data, both deep thinking people and Deep Learning AI [Artificial Intelligence], both human and machine; it requires us to question implicit biases in our algorithms and inquire deeply into not just how we build, but why we build and what we seek to improve. Fuzzies [students of the humanities and social sciences] and techies [students of engineering and hard sciences] must come together and the true value of the*

liberal arts must be embraced as we continue to pioneer our new technological tools."

In the information economy, ***human creativity is the ultimate economic resource***, and more than ever, high-value soft skills, those so uniquely human, such as working productively in teams, critically thinking, and communicating to solve complex problems—the very skills fostered and enriched by a liberal arts education—are in great demand [1 1 8]. These liberal arts skills have become *essential skills*. In this scenario, the liberal arts is the training that will increasingly be rewarded in the modern marketplace. A liberal arts-based education provides the skills that can integrate seamlessly complex thinking and creative problem-solving with the digital technologies, bringing the rigor and methods of the liberal arts to the digital environment.

5. Learning in the digital age

Investment in education is crucial to improving long-term productivity as technology continues to disrupt traditional industries or create entirely new industries. Keuka College is becoming a global leader in comprehensively integrating liberal arts, professional practice, experiential learning, and digital fluency throughout the entire educational experience. This is the education of the future.

At Keuka College, we are tackling this issue head on by offering deep understanding of a discipline's body of knowledge, in our liberal arts-based professional programs, that, when combined with digital fluency, provides the most powerful mix of skills that professionals can bring to the workplace. This new educational paradigm, labeled Digital Learning at Keuka College (DL@KC) [19] and established in 2014, focuses on how to combine digital technology ideas as integral components of our curricula.

Keuka College's "curricular revolution" is leading the way by proposing that everyone needs digital skills to succeed in today's workplace. We have been working on ways to combine all of these ideas as integral components of our curricula. The central theme of our vision is to infuse and integrate knowledge of digital technologies throughout our curricula at all levels.

To accurately define our curricular transformation, think of computational thinking (CT) [20-22] across the curriculum. CT is a problem-solving method fundamentally based on computer science concepts and techniques to algorithmically solve complicated problems of scale by manipulating data and ideas. The paradigm helps you "think" about how to solve problems in general and more specifically by following a process-driven, step-by-step approach.

The idea is to augment the professional preparedness of our graduates with a sound understanding of the fundamental underpinnings of information and the technologies that manipulate it—as well as their limitations. The key here is **augmentation.** Augmentation makes the combination of humans and computers effective. This partnership is better than either one working alone. Albert Einstein saw this earlier when he said, "*Computers are incredibly fast, accurate, and stupid. Human beings are incredibly slow, inaccurate, and brilliant. Together they are powerful beyond imagination.*"

Math is linked to physics. Statistics is linked to the social sciences. Our idea is to link computation to every discipline in a similar way. We need to add **digital fluency** to reading, writing, and arithmetic—the three "Rs" that have been the foundations of learning for thousands of years.

Adding the digital tools and computing cognitive skills "super charges" the fundamentals of other disciplines. Imagine the possibilities when combined with powerful computational tools seamlessly integrated in a digital infrastructure that the ***user community can easily exploit —because they have the technological sophistication to do so*** (i.e., the

ability to bend digital technology to one's personal or professional needs). And therein lies the rub and the solution we are proposing.

6. Conclusion

Hyper-digital transformation is too big and important to our future success not to understand the rules that apply to it. The traditional functionally trained professional is being phased out of existence. **Unless individuals can transcend technology within their professional context, they will be replaced by it.** This is the time to be a digital thinker armed with the skills to create and capture value with technology.

No one can predict what jobs will be created in the near future, let aside 10-20 years ahead. What we know is that the core skills of a liberal arts education—critical thinking, problem solving, teamwork, oral and written communication, creativity, flexibility, and an understanding of today's diverse world—prepares graduates who can adapt to changing economic factors and build successful careers.

As more and more jobs become automated with advanced technologies, liberal arts is the training that will increasingly be rewarded in the modern marketplace. The transformative experience of the liberal arts has traditionally led to successes across many different fields, and it stands to make an even greater impact in the information economy. The core practices that have made liberal arts education so successful cannot be replaced by technology. Rather, liberal arts education will interlock perfectly and reciprocally with continued technological advancements.

The greatest good Keuka College can do for our society—and for itself—is to leverage its expertise in experiential learning within its liberal arts-based professional programs to forge new professionals armed with the tools of the day, i.e., digital cyber-tools. We believe that their professional future—and ours—depends on it. This type of access to computational proficiency and knowledge is currently restricted to a few, and we are now making it available to all students at Keuka College, regardless of major, exposing them to an understanding of digital technologies and thus affording them the opportunity to develop and apply core computational knowledge and skills to make effective use of digital tools within their disciplines of specialization.

Our mission is to inspire and create digital thinkers by teaching them to think critically, communicate effectively, and contribute creatively in concert with digital problem-solving skills. Our focus is on the emergent new generation of professionals who will write code to achieve their professional goals; not only learning to code, but "coding to learn." Our idea is to forge professionals who can "connect people, information, and technology in effective and innovative ways in order to address the critical and complex issues and problems facing our fast-paced, global, and increasingly digital society … people who want to develop or use information and technology in ways that help to make the world a better place for individuals, groups, schools, businesses, governments, and society as a whole." [23]

The power of liberal arts combined with experiential and professional practice, all centrally supported by digital learning, forms the basis of what we are instilling across the curriculum: a new radical center. Since 1942, our unique version of experiential learning, Field Period®, has been the radical center powering our students' professional development. Today, DL@KC is becoming Keuka College's next radical center, a power center transforming our students' educational experience.

Keuka College is uniquely positioned to implement this novel idea and address these issues head on because our strategic plan, *E2: Empowering Excellence* [24], has put the wheels in motion to revise all our programs and learning experiences to incorporate digital fluency throughout. No other institution of higher learning has made that comprehensive

commitment a strategic centerpiece of its educational offerings. While many schools teach digital technologies, they do not teach it to all students. This is our major differentiator. We offer a genuinely different approach to learning and career preparation, ensuring our graduates are primed to make an immediate and powerful impact. We are educating what has been termed the "neo-generalist." The focus is in cultivating creativity and including not only problem solving, but also problem digital definition (computational thinking problem framing).

Digital citizenship + Liberal arts = Students empowered for life. This is the education of the future.

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