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Mitigating the Risks of Technology Backlash

"Technological advances have without doubt improved societal wealth, health, and standards of living. However, for all the tangible benefits technology creates, there is a growing disquiet that perhaps the risks of technology are beginning to outweigh its rewards."

— Robert N. Charette, Guest Editor

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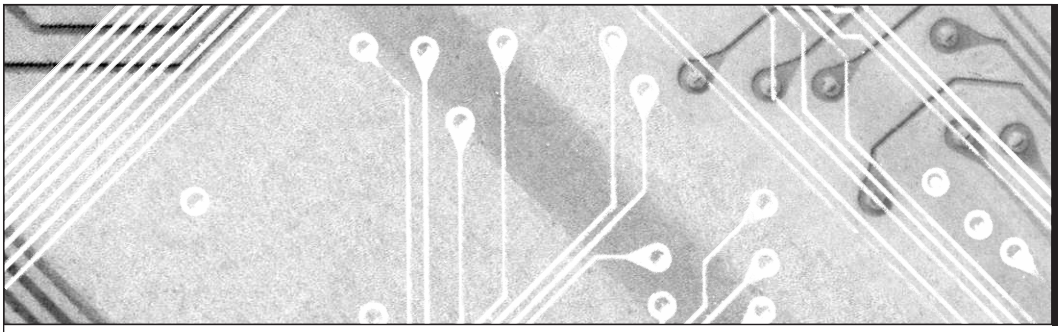

Cutter IT Journal

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Opening Statement

by Robert N. Charette

Cloud computing, data analytics, sensors and the Internet of Things (IoT), robotics, mobile and social computing, "super-intelligent" systems, and advanced cognitive systems are merely a few of the technologies that have moved from the realm of interesting ideas into the mainstream of organizational operations. Just over the horizon are not only improvements to each of these technologies, but also virtual/augmented reality systems, autonomously driven vehicles, private drones, 3D printing, quantum computing, gesture control systems, and wearable computing, among others that promise to change our daily routines in a myriad of ways.

High-tech advocates excitedly tout the many benefits of these advanced computing technologies. For example, a recent *Wall Street Journal* article titled "'Smart Cities' Will Know Everything About You" describes a future "tech utopia" where "every movement an individual makes can be tracked."[1] Individuals will have hundreds of metrics monitored through smart devices that are embedded in clothes and worn on or inside their persons.[2] Everything from heart rates to locations to sleep and eating patterns will be captured and analyzed. Are you unhappy or overtired? Not to worry, a "responsible" business will immediately know it and offer you solutions in the form of individually tailored products to alleviate your troubles. In fact, the constant monitoring of your life will even allow those nice corporations to anticipate your desires or problems and move to proactively address them. Your "preferences, behavior, and emotional state" will be transparent to all, leading to a much happier and healthier life for you, guaranteed!

At work, your life will be much more enjoyable as well. There will be intelligent robotic assistants to take away all your mundane work tasks, while others will be there to assist or augment your highly cerebral work. Only creative jobs, those that can't be automated, will be left in the future, and what's more, you'll need to spend five hours a day or less at work![3] Then, when you arrive home, your personal robotic assistants will be doing all those awful household chores, enabling you to relish all that free time.[4] With so many automated devices in your home, seamlessly connected via the IoT and constantly monitoring your every wish, your total peace of mind is ensured.

WHATEVER COULD GO WRONG?

Hmm, can't wait for the future to get here, can you? If we are to believe the technology optimists, a few short years from now advanced automation promises to bring humankind unparalleled wealth, health, and happiness. However, a few killjoys — or "neo-Luddites" as the technology optimists like to call them — have been questioning this vision of tech utopia. For instance, how willing are people to be constantly monitored by their cell phones, their clothes, or even their children's toys and then have that data sent to companies so they can figure out the best way to sell you their products? According to the Electronic Privacy Information Center (EPIC), many people are finding the idea of being monitored by always-on devices "genuinely creepy."[5]

Others are questioning the security of the information being captured. Admiral Mike Rogers, director of the US National Security Agency, recently told companies that "it is not about if you will be penetrated, but when" — an admission that doesn't exactly inspire confidence.[6] In fact, techno-optimists offer little assurance that the Internet of Things won't turn into the Internet of Thieves.

Another question has to do with automation's (un)reliability. For a smart city to operate as efficiently as claimed, for example, a multitude of highly complex heterogeneous IT systems will need to operate reliably (and securely) in unison. Yet for some reason, automated systems have this annoying habit of falling over dead, as recently happened simultaneously at the New York Stock Exchange, United Airlines, and *The Wall Street Journal*.[7] If future automated systems have even half as many glitches as current systems do, those inhabiting tomorrow's smart cities may find themselves wishing to live in today's dumb ones instead.

Some observers, such as MIT professors Erik Brynjolfsson and Andrew McAfee, are challenging the assumption of a better future world through advanced automation. In their book *Race Against the Machine*, Brynjolfsson and McAfee argue that advances in automation are destroying jobs faster than they can be replaced, which is helping to cause the wage stagnation and growing economic inequality that have appeared over the past decade.[8] It may be that future smart city office towers are almost

totally devoid of human workers, while the streets below are crowded with legions of the technologically unemployed.

ADVANCED AUTOMATION: BOON OR BANE?

Technological advances have without doubt improved societal wealth, health, and standards of living. However, for all the tangible benefits technology creates, there is a growing disquiet that perhaps the risks of technology are beginning to outweigh its rewards. For instance, Microsoft's founder and former CEO Bill Gates and Tesla and SpaceX founder and CEO Elon Musk have both very publicly warned that future advances in artificial intelligence may pose an "existential threat" to humankind in the not too distant future.[9, 10] Musk has even donated US $10 million to a group of leading AI researchers in hopes of "keep[ing] AI beneficial."[11]

Then there are those who see automation-induced risk as being immediate and personal. For example, in several countries, taxi drivers have taken to protesting against ride-service company Uber for stealing their business; in some cases, they are even assaulting Uber drivers.[12] When Google introduced its wearable Google Glass a few years ago, some users were attacked by individuals who thought their privacy was being invaded by the wearers' use of the attached camera.[13]

Pope Francis recently gave voice to many people's unease about technology when he wrote in his encyclical on climate change that "people no longer seem to believe in a happy future.... There is a growing awareness that scientific and technological progress cannot be equated with the progress of humanity and history."[14] The Pope's viewpoint, however, does not seem to have made much of an impression on technology optimists, who *do* tend to equate technological advancement with human progress.[15] New technology has always disrupted a society's status quo, they argue, but for every job lost due to the introduction of a technology, more jobs have been created. Techno-optimists consider privacy concerns overblown given how many social media users are willing to post even their most intimate activities online. Automation reliability and security may be legitimate concerns today, they admit, but those are merely technological issues that will eventually be solved.

To the optimists, pushing back against technology is about as effective as King Canute trying to stop the tides. However, backlashes do sometimes influence the future direction of a technology. The disasters at Three Mile Island and Chernobyl definitely heightened the perceived risks of nuclear power and checked nuclear power plant construction around the world.[16] Similarly, the perceived risks of genetically modified organisms (GMOs) have significantly slowed their acceptance globally.[17] Nor is automation immune. While *Terminator*-type robots may not be just around the corner, weaponized drones with autonomous "fire" decision capability certainly are, and thus the UN has begun discussions on whether to ban the development and use of "killer robots."[18] Scholars are also debating what controls may need to be put into place before self-driving cars or robots become ubiquitous.[19]

AUTOMATION BACKLASH: REBELLION, REJECTION, REGULATION

In this issue of *Cutter IT Journal*, we present six articles that discuss what appears to be a growing backlash against automation's negative impact on society. The articles explore the factors that might be driving the backlash and what might be done to mitigate them. In our first article, I examine the ideas behind the historically recurring assertion that automation destroys jobs and why those ideas persist. I also look at emerging automation technologies and contemplate why they might indeed spur societal backlashes.

Next, Hal Berghel introduces the concept of technology absurdism, which he defines as the development of technology with inadequate consideration of its potential negative externalities. Berghal writes, "Technology absurdism is unique to our postindustrial Information Age, in which the velocity of innovation has increased to the point that it is often unbridled by adequate reflection, complete context, understanding, and oversight." In other words, we may want to think a bit before giving the keys to a technological Lamborghini to a newly licensed driver.

In our third article, Paul Clermont looks at the history of technological innovation and suggests that the scope and pace of IT innovation make it unique. He argues that assuming backlash against IT is only the latest futile manifestation of Luddism may be too optimistic. He writes, "Some backlash is not just potential but likely, and it behooves the IT community to at least recognize the possibility and take actions that would mitigate it."

Like Clermont, Carl Adams, Amanda Peart, Penny Ross, and Benjamin Aziz argue that the impacts of a new technology on society should be explored before its widespread adoption so that society, business, and technology leaders can better understand its effects. They describe how this can be done through directed, multi-stakeholder, use case–driven workshops. In their article, the authors discuss how using this approach to explore the implications of the likely adoption of the Internet of Vehicles (IoV) revealed several interesting, if not perverse, unintended consequences.

Our next article is by Annie Bai, who tells companies that are looking to profit from the IoT how they can avoid creating a consumer backlash against their products and services. As she writes, "Technology backlash is as old as technological innovation," but "the cool stuff will take hold and prevail" so long as companies don't act in ways that confirm their customers' worst privacy-related fears.

Lastly, Bala Somasundaram explores the mismatch between the world of technology, with its innovative, disruptive products, and "the rest of the pillars of society ... [which] are straining to cope with the immense possibilities of the persistent technology innovations." He discusses how this mismatch, which may exacerbate social tensions, can be reduced so that society can reap the full benefits of technology.

I think you will agree that this *Cutter IT Journal* issue helps bring clarity to a very complex and controversial topic. I trust that you will find it as exciting and interesting as I do.

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Robert N. Charette is a Fellow with Cutter Consortium's Business Technology Strategies *practice. He is also President of ITABHI Corporation, a business and technology risk management consultancy. With 35 years' experience in a wide variety of international technology and management positions, Dr. Charette is recognized as an international authority and pioneer regarding IS, IT, and telecommunications risk management.*

Dr. Charette serves as a senior risk advisor to Global 100 CEOs, CFOs, and program and project managers. He is a trusted risk advisor to senior-level defense, civil, and local government officials worldwide on the effectiveness, impacts, rewards, and risks of their high-tech programs and policies. Dr. Charette acts as chief risk consultant to financial organizations and companies when investments, mergers, or takeovers are considered. His experience in both government and business provides a unique perspective on addressing the risk management issues confronting today's public sector. He can be reached at rcharette@cutter.com.

Technological Unemployment: An Absurd Worry or Valid Concern?

by Robert N. Charette

In 1954, the late management theorist and economist Peter Drucker, in his ground-breaking book *The Practice of Management*, cautioned managers everywhere that they were facing an "imminent industrial revolution" spawned by an innovative business concept called "automation," a term first coined by Ford Motor Company's VP Delmar Harder in 1948 to describe the new approach Ford was pioneering in the production of automobiles.[1] Unlike the beginnings of the Industrial Revolution in the 18th century, with its "focus on skills as the integrating principle of work," or assembly-line mass production, with its "focus on product as the organizing principle," Drucker wrote that the focus of automation centered on "process."

The disruptive power of automation, Drucker explained, first lay in its capacity to reorganize existing work and, in so doing, to make visible the underlying steps and knowledge required to perform the work. Once these were transparent, it was next possible to define, mechanize, and instrument a "best" process capable of producing a wide variety of products efficiently and cheaply. Then, as new machinery to support automation became available, additional opportunities to revisit how to reorganize work even more efficiently would arise, thereby creating even more affordable products.

Drucker emphasized that a fundamental property of automation was that it required an increase in the information content of the work being performed. Consequently, Drucker argued, workers were going to have to be more knowledgeable in order to apply the concept of automation effectively. Every improvement in automation meant a subsequent increase in the knowledge required both by those involved in building automatic machinery and those using it. Workers who could not — or would not — improve their skill sets to meet the new demands of automation would likely be left behind. Drucker warned executives that hiring or training skilled automation workers (or "knowledge workers" as he would later call them) would be a major, recurring problem for organizations.

When Drucker's book was published, fears were already mounting in the public's mind that mass unemployment à la the Great Depression of 20 years prior was once more just around the corner. The popular press was filled with news stories of "push button" factories populated by armies of robot workers controlled by "electronic brains" churning out a limitless supply of goods. A *New York Times* headline from 8 April 1955, "Automation Puts Industry on Eve of Fantastic Robot Era," was typical.[2] A massive wave of *technological unemployment* — the replacement of workers by laborsaving technology — seemed certain. These stories were given credence by many leading technologists of the time, most famously by MIT professor and world-renowned cyberneticist Norbert Weiner, who gravely warned in 1950 that automatic machinery would within 20 years "produce an unemployment situation, in comparison with [which] … the depression of the thirties will seem a pleasant joke."[3]

Drucker and most other economists scoffed at Weiner's gloomy prediction. While the introduction of new productivity-enhancing technologies such as automation — and mass-production assembly lines and steam engines before it — often led to some types of jobs disappearing, they also ended up creating far more job opportunities than they displaced. Patience, not panic, was the economists' advice to the public in the face of the coming "smart machines." Furthermore, the introduction of disruptive technologies eventually led to increases in the quality of life and work, as well as the overall standard of living. Did anyone really want to go back to the life their grandparents lived in the 1880s and 1890s, they asked?

SAME TUNE, DIFFERENT LYRICS?

A person who lived through the introduction of digital automation in the 1950s could be forgiven for having a sense of déjà vu. Once again, there is a growing feeling of unease in the public that perhaps digital automation has progressed to a point where this latest generation of

"smart machines" will indeed cause massive unemployment of today's workers. Feeding this nervousness are recent pronouncements by Microsoft founder Bill Gates, who has said that "20 years from now, the labor demand for lots of skill sets will be substantially lower," or by technology professors Carl Frey and Michael Osborne from Oxford University's Martin School, who claim that an estimated 47% of US jobs are at high risk and 19% at medium risk of being automated within two decades.[4, 5]

Most economists are much more optimistic. For example, a recent University of Chicago survey of leading economists found that some 90% agreed or strongly agreed that "advancing automation has not historically reduced employment in the United States."[6] That said, all economists concede that past introductions of automation — digital and analog — have eliminated certain types of jobs (e.g., in agriculture and manufacturing). Nevertheless, citing 250 years of historical precedents, economists will typically argue that the resulting longer-term job growth has always been well worth whatever short-term pain may be involved. Yet again, their counsel to the public is to be patient — but also to be prepared to learn the advanced skill sets that the coming automation will surely demand.

Whether today's society will indeed be patient is a question of growing debate. There is "an increasing fear of technology," Nobel laureate economist Robert Shiller said earlier this year in an interview with CNBC.[7] This fear, he explained, stems from the rapid advances along a broad front of information and computing technologies, including artificial intelligence, robotics, 3D printing, cloud computing, and the Internet of Things, among many, many others. These computing technologies, he says, seem "to be changing life in such a fundamental way and what it's leaving people thinking is 'where will I be in 30 years?… Where will my children be?'"

The anxiety that Shiller described has sparked various forms of backlash against technology that affects people's jobs. For example, the smartphone ride service company Uber has seen protests ranging from litigation against its operations to violence against its drivers by taxi drivers who believe the company is unfairly stealing away their livelihood. A 2014 PEW Research Center survey into technological change and its future impacts indicates that 30% of Americans see technology change leading to a future where people's lives are mostly worse.[8] The lower the household income and educational achievement of the respondent, the greater the pessimism expressed about the impacts of technology.

In the remainder of this article, we will explore some of the historical roots behind technology backlashes related to automation introduction and its impacts on employment. We will then look at the generator of technology unemployment backlashes, namely the automation job destruction/creation cycle. Finally, we will examine whether today's fears of technological unemployment are well founded or, as in the past, overblown.

A 2014 PEW Research Center survey indicates that 30% of Americans see technology change leading to a future where people's lives are mostly worse.

TECHNOLOGY BACKLASHES: A SERIES OF *CHICKEN LITTLE* RERUNS

Fears of technology replacing workers and sparking a resulting backlash are not new, of course. Print workers engaged in a series of strikes in France in the 1550s because of changes being made in the printing press that reduced their number, for example.[9] Perhaps the most famous backlash is the "Luddite Rebellion" of the 1810s, during which skilled textile workers sought — and failed — to stop by force the use of automated looms in factories across England.[10]

In the US, the first widespread backlash against automation for taking jobs away occurred from the late 1920s through the 1930s. From the 1910s through the 1920s, US manufacturers made significant investments in automatic (mechanical) machinery in attempts to copy and improve upon Henry Ford's idea of mass production and its standardization of parts. This investment in productivity improvement–related automation allowed significantly more products to be manufactured with far fewer employees. For instance, a 1930 article in *The New York Times* reported that as a result of factory technology improvements, "the average wage earner produced more than half again as much merchandise in 1927 as he did in 1919."[11] As a result, automation was widely blamed for the major layoffs then occurring across American factories. *The Times* of London went so far as to editorialize that same year that "the steady displacement of man by machines" coupled with the "terrifying pace of American industry" was creating a "permanent American [unemployment] problem."[12]

Henry Ford's book *Moving Forward* highlighted how the introduction of automatic technology demanded advanced workers' skills in the 1920s.[13] A 1930 newspaper review of the book stated that, at Ford, there was

"a steady shift from the less intelligent to the more intelligent worker as the automatic function grows. Rather than monotonous feeding, the operator turns designer, inspector, repairer and he must know the practical working laws of the monsters he cares for."[14] Whereas previously a newly hired Ford worker could be taught what he needed to know to perform his job in a few days, the reviewer noted, his training now could last weeks.

As I mentioned above, automation-related tech backlashes occurred in the US in the 1950s, and they did again in the late-1960s and mid-1980s, each time blamed on the successive improvements in what was often called "programmable automation." The introduction of the IBM 360 mainframe computer in 1964 radically changed how businesses could take advantage of computing to reduce the number of back-office staff, while in the 1980s, developments in computer networks, minicomputers, microprocessors, and personal computers were allowing front-office jobs to be automated. The US Bureau of Labor Statistics (BLS) estimated in 1980 that about 25% of US jobs, or about 15 million, would be impacted by automation in the near future, although it would not venture a guess on how many would actually be eliminated.[15]

There was, however, a change in emphasis developing in the debate about automation's impact on jobs during the 1980s. Wage inequality now became as important a concern as technology-driven job destruction. Automation indeed seemed to destroy jobs, but not necessarily work that needed to be performed. If it had, unemployment would continue to grow as automation eventually performed all tasks.

Even so, several leading economists, including Nobel laureate Wassily Leontief, worried that while increased opportunities for employment were being generated by the new technologies, many of the new types of jobs created were paying less than the ones they replaced.[16] Automation looked as if it was creating wage stagnation at best and wage deterioration at worse across many job categories.

There was also a sense that each improvement in digital technology was affecting an increasing number of jobs. This meant that more sectors of the economy were being disrupted simultaneously than ever before. In addition, the lag time between existing job destruction and new job creation seemed to be increasing. Together, the magnitude of automation's job disruption coupled with the growing time lag extended the economic pain felt by those losing their jobs on account of automation.

Finally, worries began to surface that the monetary benefits of technology were flowing to an ever-smaller proportion of society. With respect to technology's impact on jobs, Case Western Reserve University professor Theodore Steinberg asked, "Who gets the profit and who pays the price?"[17] It appeared that the riches were increasingly accruing to the intellectual property owners of the technology, and less and less to the users of that technology.

THE WAXING AND WANING OF TECHNOLOGY BACKLASHES

Thus far, the automation technology optimists have ultimately been proven correct: new automation technology introduction has eventually led to more net jobs and an overall higher standard of living. The diagram of the automation job destruction/creation cycle in Figure 1 — which is *highly* simplified and idealized — helps explain why technology backlashes arise, then eventually disappear, only to reappear again later.

For discussion's sake, let's assume that we are the owners of a company that has decided to invest in automating an existing process we use to manufacture some product. Our goal is to make that product cheaper, faster, and hopefully better in order to compete more successfully in the market. Assuming that our automation project goes well, a question we need to answer is whether we need all the labor that we employed before. Deciding we have significantly increased our manufacturing productivity, we sadly let some of our employees go. We do need, however, to make some investment in upgrading the skill set of our remaining employees to ensure that they operate our new automated process reliably.

Now let's say that our automation effort (including the saved labor cost) has enabled an effective 25% reduction in the cost of producing our product, and that we decide in turn to lower our product price by 15%, pocketing the difference. Furthermore, the result of our price cut acts to significantly increase the sales of our product (which we can easily handle due to the increased productivity we gained from our investment in automation), as people who couldn't afford our product previously now rush to buy it, and our existing customers buy more of our product as well. This not only helps our bottom line, but the cost savings accrue to our customers. This in turn allows our customers to spend the money that they are no longer spending with us on other types of products that perhaps they could not afford previously, thereby helping countless other companies' revenues as well.

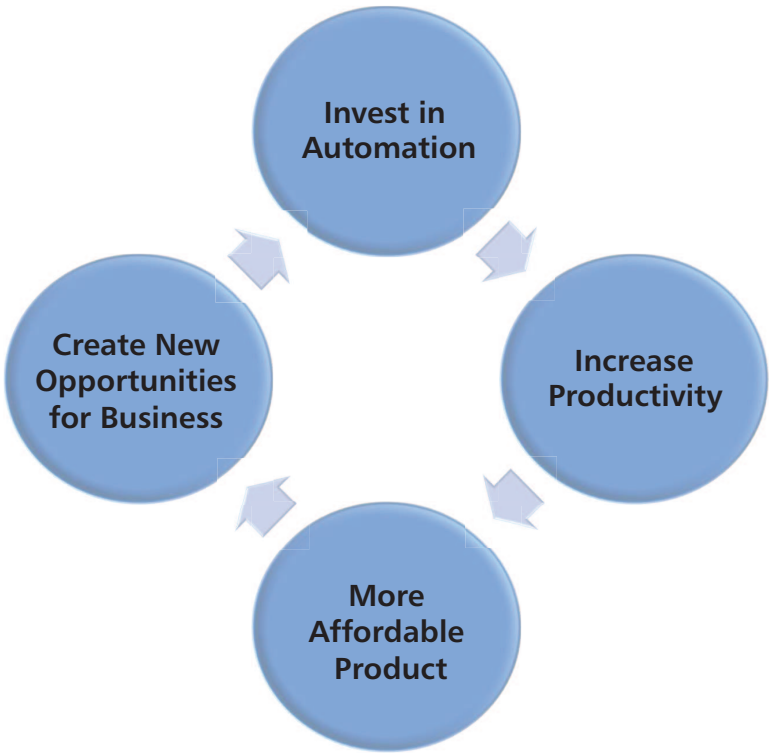

Figure 1 — The automation job destruction/creation cycle.

In addition, the increase in sales and the cost savings resulting from our automation investment makes us contemplate expanding our product line in new directions. This probably means hiring new product designers and engineers, as well as possibly hiring back some of our laid-off employees to operate the new manufacturing line. It will also likely spur our competitors to make automation productivity investments using even more advanced technology than ours to remain competitive with us, including the probable reduction in the price of their competing products.

Moreover, let's say that our product's price reduction has encouraged a group of entrepreneurs to start a business that makes use of our product because our investment in automation has now lowered their business risks to an acceptable level. If their venture is successful, they will need to hire many types of skilled employees to grow their business. As this new business grows, it will also likely need to invest in automation to become more productive, and another cycle of job destruction and creation begins anew. And, of course, it helps increase the revenue of our company, which we can further invest.

Therefore, ideally at least, while our investment in automation may indeed do short-term localized harm, it eventually creates a lower-risk business environment that encourages the formation of new businesses and the expansion of current ones, spurs investment in even newer automation technology, and creates new jobs all around. Multiply this situation by tens of thousands of businesses big and small, and you can understand why technology optimists counsel patience whenever automation looks as though it might cause massive job losses.

OK, you might be tempted to say, this seems to be the end of debate. The automation has some downsides, but if the public can persevere, the investments in automation will help grow the economy and create jobs, at least for those with the right skills. Then why, you might also ask yourself, are so many economists like Schiller and technologists like Gates — who know the history of automation — still so concerned? Is there something different this time around about the automation jobs destruction/creation cycle?

THERE'S SOMETHING HAPPENING HERE, BUT WHAT IT IS AIN'T EXACTLY CLEAR

The outward signals seem to point toward "yes," that something different *is* going on, at least in comparison to past introductions of automation advances. For instance, the recovery from the current economic difficulties has been extremely slow since the recession ended in the US in June 2009. Some economists have called it the "jobless recovery" and have pointed a finger at business

investments in automation as one culprit.[18] Businesses have found that they could achieve their desired performance objectives by investing in automation instead of workers, especially for jobs involving the performance of routine work. As one might predict given how automation increases the knowledge content of work, the jobs that employers have been hiring for require ever-higher levels of education and skills, especially technical skills (i.e., those associated with information technology). In fact, the BLS has projected that through 2022, one of the fastest-growing sectors of the US economy is in IT and related fields.[19]

One of the primary targets of automation has been the elimination of high-paying occupations that were once thought to be immune to automation, including jobs in the accounting, financial management, legal, media, and medical fields.

But even there, the news isn't all good. Except for some specific technical skills (e.g., advanced data analytics), the salaries for US IT workers have remained relatively flat for over a decade. One reason for this, of course, has been the globalization of the world's economies over the past 30 years, where technical jobs can easily be outsourced to countries with lower wage costs.

New automation technology is also promising to eliminate many types of skilled jobs in the future, not just routine work as in the past. In fact, one of the primary targets of automation has been the elimination of high-paying occupations that were once thought to be immune to automation, including jobs in the accounting, financial management, legal, media, and medical fields. The highest-paid physicians are proving to be an especially inviting target for displacement by advanced automation.[20]

However, the impact of automation will still be felt most keenly in routine jobs. For example, one type of very common job that looks ripe to be eliminated by automation is the driving of trucks. The incredibly rapid rise of autonomously driven vehicle technology is promising to massively disrupt the trucking profession (as well as other hired vehicle industries) and associated supporting industries. Transportation analysts at Morgan Stanley, for example, are predicting that 10 years from now, the trucking industry will be totally transformed, with 2 million to 4 million or more persons currently employed in the trucking industry potentially looking for new work.[21]

Even if Morgan Stanley's predictions are overstated, it seems clear that automation is going to have a major impact on all forms of land (as well as air and sea) transportation over the next two to three decades and some effect on the jobs associated with them. The potential effects of advances in 3D printing could have an even greater impact on employment. Advanced experiments are already being undertaken with the purpose of creating buildings, automobiles, human body parts, motorcycles, and possibly even aircraft using this technology.[22] The employment effects on manufacturing and construction could be even greater than those involving autonomously driven vehicles.

What is perhaps most concerning to economists like Schiller is that the capability and cost of automation are improving rapidly across so many fronts. The cost of robots is dropping incredibly fast, and their functionality improving so quickly, that many analysts predict that by 2025 it will make economic sense to use robots in at least 25% (if not more) of all existing manufacturing jobs.[23] By 2035, the number could easily be double or more than that figure.

A more subtle concern, but one with potentially the greatest negative effects on employment, is what happens if the new jobs that future investments in automation create are so knowledge-intensive that it makes more economic sense to use more automation to perform them than to hire skilled people. It may be that many future jobs are open for smart machines only.

DON'T WORRY, BE HAPPY?

The march of automation will not be stopped. Is it poised to put everyone out of work? If one looks at history, the answer seems to be a resounding "no," and that fact is the rationale given by many technology optimists who dismiss all concerns about a future of massive technology-driven unemployment. It hasn't happened in any major way in the past, ergo it won't happen in the future either. There are always more human wants than available resources, this argument goes, so there is always more work to be done.

That may be valid, but it may not be work that pays very well. Interestingly, only 20% of those same economists polled by the University of Chicago felt that IT and automation were *not* a central reason why wages have been stagnant for the past decade. This situation is not likely to change anytime soon. In addition, while

investments in automation may indeed create a greater number of jobs than in the past, they will also no doubt require higher educational skill levels on the part of workers to perform them. Given that the average cost of higher education at a US public university has nearly doubled in the past 20 years, how to afford to gain those skills is becoming the question.[24]

If future jobs end up paying far less than in the past but the cost of qualifying for them continues to skyrocket, then "technology backlash" may not be an apt descriptor. A technology-driven social revolution that makes the Luddite Rebellion look tame might be the unhappy result.

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Robert N. Charette is a Fellow with Cutter Consortium's Business Technology Strategies *practice. He is also President of ITABHI Corporation, a business and technology risk management consultancy. With 35 years' experience in a wide variety of international technology and management positions, Dr. Charette is recognized as an international authority and pioneer regarding IS, IT, and telecommunications risk management.*

Dr. Charette serves as a senior risk advisor to Global 100 CEOs, CFOs, and program and project managers. He is a trusted risk advisor to senior-level defense, civil, and local government officials worldwide on the effectiveness, impacts, rewards, and risks of their high-tech programs and policies. Dr. Charette acts as chief risk consultant to financial organizations and companies when investments, mergers, or takeovers are considered. His experience in both government and business provides a unique perspective on addressing the risk management issues confronting today's public sector. He can be reached at rcharette@cutter.com.

Technology Abuse and the Velocity of Innovation

by Hal Berghel

TECHNOLOGY ABSURDISM

Technology absurdism is the development of technology that ignores, fails to appreciate, or underrepresents obvious negative externalities.[1] Let me show you what I mean with a few examples.

Rust? Never Heard of It

In the past year, the US National Highway Traffic Safety Administration announced the recall of defective Takata air bag inflators in nearly 34 million automobiles,[2] the largest recall in US automotive history. After several years of study, Takata has reached a "preliminary conclusion" as of 18 May 2015 that the inflators can rupture. No news there — the victims had that figured out on impact. Takata reports that "it appears that the inflator ruptures have a multi-factor root cause that includes the slow-acting effects of persistent and long-term exposure to climates with high temperatures and high absolute humidity"[3] (read: they rust and don't stand up to heat). Takata has determined empirically in their lab that .51% of the inflators in hot and humid climates will rupture. They estimate that .25% of passenger airbags deploy in the field each year. So if you're unlucky enough to own one of the recalled cars that were operated in hot and humid environments for a while, your risk of wearing metal shard cologne may approach one in a thousand this year.

That the Takata airbags were not ready for prime time is really not at issue here. Let's analyze this recall from the point of view of product development and engineering. The analytical substance is as simple as our father's admonition not to leave his tools outside when we're done with them. Rust is not a foreign concept that is just now creeping into our technical vocabulary. For the past few millennia, it has been associated with iron and moisture. Just what manner of metallurgy was Takata using that ignored the combined effects of moisture and heat on steel parts? The real story behind this recall has to do with accelerated prototyping and rush-to-market, inadequate product testing, lax oversight, a risk-benefit analysis gone awry, and a preoccupation with cost savings. All of these combined in a race to the bottom in terms of product safety involving technological shortcomings known since the Iron Age.

It Depends on What You Mean by "Prevent"

The proximate cause of the Takata recall is not too dissimilar from the 2010 Gulf of Mexico oil spill. On 20 April of that year, the BP Horizon exploration rig blew up. It was located 49 miles off the coast of Louisiana and drilling at a depth of more than three miles below sea level. Eleven crewmembers lost their lives, others were injured, and the largest oil spill in US history resulted. In January 2011, President Obama's National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling reported that this accident was entirely avoidable and due to failures at all levels of management.[4] But there are shades of Takata in this story as well.

A fail-safe device — a "blowout preventer" — was in place at the time of the spill. It was specifically designed to prevent what happened from happening, management failures or not. But this blowout preventer's "deadman" system failed to deploy during a poorly implemented temporary abandonment procedure. It seems that no one had bothered to test the blowout preventer to see if it would work in this application! As a consequence, lives were lost and 5 million barrels of crude polluted the Gulf of Mexico. The blowout preventer is the analog of the airbag inflator!

The Cost of Doing Business

There is another variation on technology absurdism that bears mention. This results when a technology solution for a known risk is both understood and available but is intentionally not used, usually for economic or political reasons. The delayed introduction of seat belts by the automobile industry was a product of the latter's risk-benefit analysis: it was more cost-effective to settle with the victims after an injury than to invest in seat belts to prevent the injury. A current example of this reasoning is to be found in recent resistance by the US rail

industry to introducing positive train control (PTC), which can automatically stop a train to prevent certain kinds of accidents from occurring. The Amtrak derailment in Philadelphia on 12 May 2015, which resulted in eight deaths and over 200 injuries, highlights the dangers inherent in letting cost override safety considerations. The value of PTC has been understood for decades, but weak congressional resolve allows the rail industry to avoid the expense.[5] As a data point, the 2008 Rail Safety Improvements Act,[6] which mandated that each Class I rail carrier develop a plan for PTC by 31 December 2015 and have it installed by 31 December 2018, is not likely to be enforced anytime soon. At the request of the rail industry, several US senators have proposed that even the 2018 date be deferred.

Congressional response to the ever-increasing risk, combined with the growing unprofitability of Amtrak, led to a 1994 law that capped the single accident limit at US $200 million (or $126 million in 2015 dollars).[7] This is classic political reasoning: reduce the risk to the political donor class by limiting the liabilities of potential claimants. History has recorded the effect. The disastrous train collision that took place in the Chatsworth district of Los Angeles in 2008 pushed casualty liabilities so far beyond this cap that the presiding judge had to lower the cash payout he calculated by 25% to fit within the legal limit.[8] From the point of view of politicians, and the transportation industry that supports them, lowering the settlement cap and delaying implementation of PTC is preferable to investing in public safety, as long as there are no criminal penalties that accrue to the transportation executives and the civil penalties remain modest. It's just the cost of doing business, much the same way that moral hazards are handled in banking and finance.[9]

Technology absurdism is an epidemic that needs to be addressed. The solution is neither obvious nor easy to implement, and those of us in positions of technology leadership, or who are domain knowledge experts, need to take responsibility for a measurable part of problem.

DIGITAL WRIGHTS MANAGEMENT AND ENERVATION

The realm in which technology absurdism reigns supreme is information technology. Low entry-level costs, easy access to computers and networks, widespread availability of high-quality malware, a wide base of development software, and huge potential markets for inexpensive products make this the absurdist's environment of choice for poorly thought through ideas.

Pillow Talk

My favorite exemplar at the moment is my new WiFi-enabled bed.[10] I know what you're saying: sure this bed will work with Static IP, but can it work within a Class C sleep space served through DHCP? Well, yes it can. And, of course, both Apple iOS and Android apps are available for your smartphone.

Now I understand the allure of functional product differentiation, but I'm not seeing the unique sales proposition here. Rather, this slumber feature tells me that there are too many STEM graduates who have too much time on their hands. In this case, we'll refer to the anonymous enervators collectively as "bedwrights" and subsume the fruits of their labors under the newest form of intellectual property protection: digital wrights management (DWM). Similarly, those who might seek to circumvent DWM shall be known as hacklers, as in "She's being prosecuted for hackling into the CEO's Web bed." What is the appropriate boudoir information security policy? Would porting over the default policy from the family room be considered an egregious breach of our trust model? Inquiring minds want answers.

The realm in which technology absurdism reigns supreme is information technology.

Could've Seen That Coming

Surely one of the most egregious breaches of digital best practices as well as truth in advertising was the recent TRENDnet IP Security Camera public relations fiasco.[11] According to the US Federal Trade Commission (FTC) complaint,[12] TRENDnet's SecurView IP cameras were never all that "secur." Specifically, it alleges that the "respondent has engaged in a number of practices that, taken together, failed to provide reasonable security to prevent unauthorized access to sensitive information, namely the live feeds from the IP cameras," including transmission and storage of login credentials in cleartext, failure to respond to user and third-party vulnerability reports, and failure to test their bundled software. By the time of the FTC complaint, hackers had posted links to 700 Internet-connected security cameras for all to see. After two years and extensive media coverage, TRENDnet patched their software. On 16 January 2014, the FTC ordered TRENDnet to introduce security protection into their SecurView product line that is consistent with their product representations.[13]

My objective here is not to beat up on TRENDnet — for they have wandered no further afield of citizens' privacy expectations than other high-tech companies[14] — but to reinforce the point that technology absurdism in one form or another is rampant. In this case, TRENDnet failed to embrace any reasonable interpretation of industry best practices for Web video security and privacy since the earliest days of the Web. In terms of user security and privacy, the operational differences between the SecurView Web camera system and the analog baby monitors of the 1990s were purely cosmetic.

There are several categories of technology that positively invite technology absurdism.

A Banner Decade (for Hackers)

It is worth mentioning in this regard that some of us feel that the concept of the Internet-enabled security camera is still not ready for prime time. One of the attack vectors exposed in the TRENDnet and related compromises is actually a TCP/IP feature, namely that IP-addressable services require service banners in order to function. So-called Internet banners are really only the protocol headers offered by the servers for session negotiation (protocol version supported, server-side Web software and version numbers, etc.). This information must be public because it is required for the connection to work. But these banners all too frequently give up more information than needed, such as default passwords, GPS data, and configuration settings. This applies to all common TCP/IP protocols, including those used by industrial controllers, traffic signals, nuclear power plants, and other miscellaneous componentry in our ill-conceived Internet of Things.

In fact, there is a search engine designed specifically to search for Internet banners: Shodan.[15] Shodan now searches for over 170 Internet banners in much the same way that Web search engines locate HTML data. What is more, Shodan was launched a year before TRENDnet's undersecured Web cameras were first sold. From any reasonable security and privacy perspective, exposing security camera imagery to the entire Internet has never been a good idea, and connecting a camera (or baby monitor, or what have you) to any network without verifiably robust security practices in place has been downright irresponsible for most of the past 50 years.

Be that as it may, the FTC's complaint against TRENDnet was twofold: best security practices weren't followed, and, more importantly, the corporate claims of security and privacy protections were vast overstatements if not downright misrepresentations.

As I write this, Omron, a manufacturer of programmable logic controllers, makes the following claim of their product:

> ... the security risk [of using Omron PLCs] is very low. Hackers and other evildoers, when they are attempting to "hack" into a network, usually go through a process of Port Snooping to determine what UDP and TCP ports on a router are open and connected to a PC (vulnerable). Standard Ethernet communication protocols are used in this process. When a router is forwarding a TCP or UDP port to an Omron PLC, the traffic is being delivered to a non Windows based operating system. *This makes the PLC impenetrable to standard hacking methods*."[16] (italics added)

The quoted analysis goes well beyond naïve and uninformed. It amounts to digital blasphemy. That this report remains online and was reported on the Shodan blog on 9 February 2015 should not be overlooked!

TECHNOLOGIES THAT ARE RIPE FOR ABUSE

What's the Frequency, Kenneth?

Let's move from the specific to the general. There are several categories of technology that positively invite technology absurdism. Certainly the use of radio frequency (RF) technology — whenever privacy and security are of concern — is at the vanguard of this movement.[17] Examples of engendered RF mistakes include the Western Hemisphere Travel Initiative's passive RF-based PASS card, which showcases the military-industrial-surveillance complex's penchant for technology absurdity. Another is the deployment of RFID cards and tags modeled on faith-based security standards (read: if I wish it to be secure, then, by definition, it is).[18] A third example is the development of the Wired Equivalent Privacy protocol in 802.11 WiFi.[19] This last example has the additional twist that the vulnerability was actually built into the IETF standard. As I've written about these topics elsewhere, I'll suppress the temptation to elaborate here.

Can't Fight the (Global Positioning) System

Another technology that is just ripe with opportunity for technology abuse is the Global Positioning System (GPS). GPS distinguishes itself by offering both a security *and* a privacy vulnerability. From the security

perspective, commercial GPS is easily spoofed.[20, 21] This is easily understood if one thinks back to the Clinton Administration's elimination of Selective Availability (SA) in May 2000. One may recall that in years prior, accuracy was measured in tens of meters. After SA was eliminated from commercial GPS, accuracy increased to within a few meters on average. Spoofing in this sense is just a way of turning SA back on through "satellite cloning." It arises because commercial GPS uses triangulation based on unencrypted and unauthenticated signals. As with RF systems generally, connection is established with the strongest available signal. So any GPS signal that "spoofs" a legitimate GPS satellite signal with a stronger one can provide data that will be used by the triangulation algorithms. Todd Humphreys, director of the University of Texas at Austin's Radionavigation Laboratory, has demonstrated empirically that spoofing can easily produce GPS "blunders" (triangulation error measured in miles).[22]

Not only was GPS spoofing understandable at the design stage, its use as a vulnerability was entirely predictable. (For this reason, the US military adopted an anti-spoofing module over a decade ago.) However, that doesn't help the typical commercial GPS user. This is to say nothing about the triviality of GPS jamming where a criminal or terrorist wants to produce a crash but isn't terribly invested as to time and place.

Mind My Dots, Maparella

Perhaps more insidious is the use of GPS dots[23] — micro GPS transponders about the size of a slice of a typical pencil eraser that may be used to triangulate to a position. Absent regulation, GPS dots will become inexpensive and ubiquitous in the years to come. That will result in GPS dots becoming the surveillance target of choice by snoops everywhere — government spy agencies, divorce attorneys, law enforcement, government contractors, criminals, and predators alike. Only in this case, abuse of such trackers will not run afoul of government regulators, at least not in the US. To my knowledge, there is no federal statute that regulates such surveillance by nongovernment interests.

THE DEVOLUTION OF INNOVATION

I offer for your consideration "Gresham's Twist on Moore's Law" — namely, that the world's capacity to create absurd technology doubles every 18 months, where absurd technology is to be understood in the sense explained above. Technology absurdism is unique to our postindustrial Information Age, in which the velocity of innovation has increased to the point that it is often unbridled by adequate reflection, complete context, understanding, and oversight. This was not the case in the kinetic and analog world of our parents and grandparents. While they may have lived in a Rube Goldberg world, we live in a world defined by hazards identified by George Orwell and Aldous Huxley.

It is precisely this velocity that is the cause for concern. Innovation came gradually to the Industrial Age. Morse's wired telegraph (1837) was separated in time from Marconi's wireless telegraph (1894) by over a half-century. That provided an ample temporal palette for refinement and contextualization. It also enabled society time to adapt. Note that Wheatstone's ABC character input telegraph (1840), Bain's facsimile machine (1843), Hughes's keyboard telegraph (1855), Bain's chemical paper printer (1846), Phelps's motorized teleprinter (1880), and the message-routing telex system (1930) were spread out over nearly a century after the invention of the telegraph. That allowed each innovation to mature at more or less its own speed, building upon past achievements, finding its own niche, and, for the most part, negotiating a responsible pathway to market. Had all of these advances occurred in the same decade, technological chaos would have worked against their maturation process.

While our parents and grandparents may have lived in a Rube Goldberg world, we live in a world defined by hazards identified by George Orwell and Aldous Huxley.

In effect, that's the problem high-tech innovation faces today. I like to think of this as technology devolution (in the biological sense), where there isn't time for the technology equivalent of natural adaptation to take effect. Progress is blocked because mutations take place more or less randomly, concurrently, and independently. Had this happened in biology, Darwin would have documented wildly implausible and ephemeral organisms that devolved into chaos rather than evolved into order. Biological devolution would lead from complex life forms to those more primitive and purposeless. However, the devolution of high-tech innovation turns otherwise useful technology platforms into those of dubious value that may work against society's interests. Not that this effect is intended. It is produced by errors of omission rather than commission. Society lacks the

time to detect and purge the worst of the bad ideas before widespread adoption. This responsibility is left to technologists.

Unfortunately, in this devolutionary climate, we have the worst ahead of us. Poorly designed vehicle telematics are easily hacked, turning microlevel controls used by antilock braking systems into nightmarish hazards at freeway speed. RF-enabled pacemakers and insulin pumps invite hacking. Cell phone kill switches (now required in many jurisdictions) offer a bouquet of incentives for the criminal elements, from bricking mobile devices as a barrier to evidence collection to preventing victims from calling for help. Microtaggants abound for misplaced surveillance and invasion of privacy. Perfluorocarbon scent emitters are ideal for covert tracking of the unwary. Add to that an expansion of drone space without antecedent community agreement on privacy expectations, driverless cars and robots that invite weaponization, and the ill-conceived Oregon mileage-based gas tax (which, by taxing miles driven rather than gas consumed, actually penalizes fuel efficiency), and our future looks dim even by the standards of Orwell and Huxley.

The velocity of technology innovation needs to be throttled to the point where society can control it.

With innovation occurring at current velocities, wherefrom are the best practices to spring? The answer is not to be found in industry, for companies are incentivized to accelerate the introduction of new products rather than reflect on how well they serve society. Nor is the answer to be found in a political process fueled by special interests. Higher education can certainly play a role, but only if there are courses that deal with regulating innovation as a social good, rather than racing toward it for economic reasons. If there are such courses, I haven't seen them, and they're unlikely to fit well into the entrepreneurship programs so much in vogue these days. I'm not at all confident that academic leadership will rise to this challenge anytime soon.[24]

That pretty much leaves technology leaders, who must include some understanding of how to identify the potential negative externalities of an innovation before deploying it. In each of the examples I gave above, competent domain experts knew, or should have been able to anticipate, the potential abuses that resulted. This is indeed not "rocket science." That's not to say that technology leaders can deflect an organization's first-to-market mentality, but they can inform and document potential negative externalities in white papers for corporate and government leaders to consider. Our industry demands more iconoclasts!

If we accept the premise that not everything we can do is worth doing (not an unreasonable assumption), the preposterousness of accelerating innovation without full consideration of negative consequences is easier to spot as an absurdity. The velocity of technology innovation needs to be throttled to the point where society can control it. And there are no external controls that are adequate to this challenge. Knowledge domain experts are the appropriate change agents lest the executives remain stuck on stupid. This is not Luddism, but lucidity.

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Hal Berghel is currently Professor of Computer Science at the University of Nevada, Las Vegas, where he has previously served as Director of both the Schools of Computer Science and Informatics, and as Associate Dean of the College of Engineering. In 2005, Dr. Berghel created and directed Nevada's first CyberSecurity degree programs (bachelor's, master's, and PhD), which became an NSA Center for Academic Excellence. He was the founding Director of the Identity Theft and Financial Fraud Research and Operations Center and CyberSecurity Research Center. His research interests are wide-ranging within the binary and digital ecosystem, ranging from logic programming and expert systems to relational database design, algorithms for non-resolution-based inferencing, approximate string matching, digital watermarking and steganography, and digital security and privacy. Since the mid-1990s, Dr. Berghel has applied his work in digital security to law enforcement and intelligence gathering, particularly with respect to digital crime, digital money laundering, information warfare, and trusted identities. His research has been supported by both industry and government for over 30 years. In addition to his academic positions, Dr. Berghel is also a popular columnist, author, frequent talk show guest, inventor, and keynote speaker. For nearly 15 years he wrote the popular "Digital Village" column for the Communications of the ACM*, and he has written the "Out-of-Band" column for* IEEE Computer *since 2011.*

Dr. Berghel is a Fellow of both the IEEE and the ACM and serves both societies as a Distinguished Visitor and Distinguished Lecturer, respectively. He has received the ACM Outstanding Lecturer of the Year Award four times and was recognized for Lifetime Achievement in 2004. He has also received both the ACM Outstanding Contribution and Distinguished Service awards. Dr. Berghel is also the founder and owner of Berghel.Net, a consultancy serving government, business, and industry. He is a member of the Nevada Technology Crimes Advisory Board and chairs the Nevada Privacy Subcommittee. He can be reached at hlb@berghel.net.

Technology Backlash: Will This Time Be Different?

by Paul Clermont

A FEW FACTS ABOUT TECHNOLOGY

Technology and its advancement distinguish *Homo sapiens* from the rest of the world's menagerie. Who would disagree that technologies, defining the term broadly, have wrought wondrous improvements to virtually every aspect of our lives — work, play, mobility, health, safety, social connectedness, and so on? Without technology in the broadest sense, our species would still be hunting and gathering at the mercy of microbes and weather.

Any discussion of backlash against technology should start by acknowledging some basic facts:

- While many technologies enable us to do something we otherwise could not do, like air travel, others take over a task once done by humans, right back to the first time a beast of burden was pressed into carrying a load that might have required several people.
- Technologies never have job creation per se as a primary goal, but it is almost always a by-product.
- Technologies create winners and losers in the labor market. Winners are those with the inherent ability to work at a higher level or the adaptability to do something different. Losers are those who can't, won't, or lack the opportunity.
- Historically, the jobs technologies destroy have typically been arduous, boring, unsafe, and generally lousy, requiring minimal skill. (In IT's case, though, that is changing. We'll come back to this.)
- While some of the new jobs technology created have still been boring and sometimes unhealthy (e.g., assembly-line production), many require more — often much more — skill, from the first horse and camel drivers right through to engineers, managers, and computer scientists.

The massive unemployment each wave of laborsaving technology might have engendered has not materialized. In addition to the replacement jobs, compulsory education, prohibition of child labor, regulation of workweeks, and the concept of retirement have reduced the size of the workforce in beneficial ways. Unemployment among working-age people fluctuates but has not gone out of control since the Great Depression, and in that case, the widespread unemployment was not blamed on technology.

But is what's past *always* prologue? In this article, I suggest that our mostly positive history of adjusting to technological innovations may not be a trustworthy guide to the future when we consider the extraordinary scope and pace of IT innovation. To assume that any backlash against IT is no more than the latest futile manifestation of Luddism may be too optimistic.

FATHER OF THE INDUSTRIAL REVOLUTION

Who is the father of the Industrial Revolution? Sir Richard Arkwright (1732-92) is often given that honor. In the 1770s, this humbly born and self-educated inventor and entrepreneur created ways to mass-produce (by the standards of the time) dyed cotton cloth in a huge (again for the time) factory in Cromford, England, one of the first of its kind. He became a very wealthy man, a model of merit-driven upward mobility followed by Thomas Edison, Henry Ford, and Steve Jobs.

HISTORICAL BACKLASH

A corollary of the fact that technologies create winners and losers in labor markets is that they decrease the bargaining power of the less skilled, at least when there's no shortage of available labor, and that condition has prevailed through most of history. The pace of technological development was steady but slow until about the middle of the 18th century, when knowledge generated by early scientists began to be applied to mundane activities like weaving, knitting, and dyeing. Factories appeared where there was falling water to be harnessed for power. (See the sidebar "Father of the Industrial Revolution.")

Most factory jobs were mind-numbingly repetitive, but plenty of new jobs were created to design, build, and maintain the machinery; to supervise the workers; and to operate what we'd now call a business infrastructure, including accounting, production, inventory control, and sales.

Working conditions in these "dark, satanic mills," as the poet William Blake described them in 1808, were awful. Semiskilled workers toiled away for 12 hours a day, six days a week, with only two holidays a year. (That's 3,732 annual work-hours, about twice the current average.) This provoked one of the first notable backlashes against technology, as Luddites translated words into action by smashing textile machinery. Though remembered for their sabotage, the Luddites' anger was not so much against machinery as such, but rather poor pay and working conditions in mechanized factories.[1] Author Richard Conniff writes that:

> [P]eople of the time recognized all the astonishing new benefits the Industrial Revolution conferred, but they also worried, as [the Scottish essayist Thomas] Carlyle put it in 1829, that technology was causing a "mighty change" in their "modes of thought and feeling. Men are grown mechanical in head and in heart, as well as in hand." Over time, worry about that kind of change led people to transform the original Luddites into the heroic defenders of a pretechnological way of life.[2]

This form of nostalgia is still alive today, as people who can afford to willingly pay a premium for artisanal products.

The bargaining power of factory labor remained low throughout the 19th century as the supply of workers expanded due to better public health and immigration from poor countries, so pay and working conditions did not improve until the union movement and social activists shifted the balance of power in the early 20th century. Rapid expansion of new industries, like auto manufacturing, plus workweeks shrinking by nearly half helped factories absorb the continuing influx of workers from immigration and no-longer-needed farm labor.

COMPUTERS ARRIVE

Computers emerged from scientists' laboratories in the early 1950s to be applied to mundane business operations. John Diebold (1926-2005), the first real guru in that field, essentially coined the term "automation"[3] in his book of that title.[4] The prospect of displacing armies of clerks and factory hands with automation led to some serious concerns about massive unemployment, but no popular backlash emerged; the 1950s were a time of unquestioning belief in "progress," and the baby boom had not yet hit the labor market. (Plus, there was the Cold War to worry about.)

The 1960s saw some populist concerns about automation,[5] but the space race had made science and technology fashionable. Furthermore, IT was still limited in its application by the high cost of raw computing power and data storage. Hordes of new jobs were created, both to program and tend the computers and, given all the data now retrievable, to extract knowledge and insight from it. Nor should we forget Parkinson's Law:[6] work expands so as to fill the time available for its completion.

Also offsetting the potential net job loss was the fact that a great many early computer systems were not well conceived or designed, so their laborsaving benefits fell far short of expectations. This outcome inspired MIT economist (and Nobel laureate) Robert Solow to quip in 1987: "You can see the computer age everywhere but in the productivity statistics."

IT FLEXES ITS MUSCLES

The "productivity paradox" bemoaned by Solow and others did not last long. Business and IT managers got smarter with techniques like reengineering, software vendors improved their products, the Internet happened, and, more than anything else, dramatic declines in the cost of hardware and telecommunications opened up endless opportunities for digitizing just about anything. No longer was IT only about numbers and their manipulation:

- Word processing and optical character recognition (OCR) added text to the mix.
- Computer-aided design (CAD) added drawings that could be manipulated, eliminating the need for draftsmen.
- Physical processes in three-dimensional space were encoded to let robots perform assembly-line tasks. While robots for manufacturing jobs raised concern in the 1950s, they did not really come into play until the 1980s. Early computer gurus did not appreciate that it was harder to teach a computer to drive a robot across a cluttered room without bumping into things than it was to teach it to play Grandmaster chess. (See the sidebar "A Tale of Two Assembly Lines.")
- Global debit and credit cards, self-service card readers, and barcodes have eliminated vast numbers of bank tellers, inventory and checkout clerks, and gas station attendants.

- Office automation has made the traditional secretary a perk reserved for the highest-level executives.

Two additional capabilities extended the impact of IT well beyond assembly-line workers, clerks, and secretaries:

- Standardized digitization of previously incompatible and fixed forms of information — books, documents, drawings, pictures, photos, videos, recorded sound — allow manipulation, comparison, and analysis.
- The Internet lets digital data traverse the world in bulk at the speed of light through fiberoptic cables.

This global availability of the full range of digital data has enabled a world market in higher-level professional jobs that once could only have been done locally. Even time-critical tasks like X-ray reading and fine-tooth review of legal documents have come into play. When well-trained, English-literate folks can get the source documents in India as fast as someone just down the corridor and do the job as well for a fraction of the cost, well …

The outsourcing of computer work to low-wage countries is old news, but it recently became a headline issue when Disney and Southern California Edison each discharged several hundred IT workers who, before departing, had to train their Indian replacements brought in on H-1B work visas. Since those visas were not designed to allow employers to replace Americans in existing jobs,[7] a bipartisan political issue has emerged.

Taken to its logical conclusion, a borderless job market means that unless a rich country's workers are demonstrably more skilled and productive than those in low-wage countries, they will have to accept poor-country wages to keep their jobs.

A TALE OF TWO ASSEMBLY LINES

In 1987, I walked down a corridor separating two assembly lines in the Ford plant in Cologne, Germany. One side made the Fiesta, an economy model in production for a number of years. Workers wielding heavy shoulder-mounted guns did the body welds. The other side made the Scorpio, a recently introduced upscale model. Robots in a mesmerizing ballet did the welds while a sole employee kept an eye on the process. The jobs of the Fiesta workers (mostly immigrants) were not "good," but they were probably better than anything on offer back in Turkey.

THIS TIME, IT'S NOT JUST JOBS

The extensive list of what digitization is currently doing raises the possibility that this IT onslaught really *is* different from any past technological wave. Maybe it means more than just destroying some jobs while creating other, better ones. What is fundamentally different?

IT's ever-growing capabilities and ever-decreasing costs have made it truly ubiquitous; for example:

- Cars, appliances, and even whole houses use special-purpose computers for control and the Internet of Things to communicate.
- Driverless cars are rapidly moving out of the pages of science fiction magazines.[8]
- Handheld devices using satellites or the cellular network can pinpoint where we are.
- Miniaturization has allowed our interface to just about anything digital to fit in a shirt pocket. Smartphone apps can control our thermostats and digital video recorders from the other side of the world, not to mention making photos and videos that can be immediately transmitted.

Furthermore, existing technologies just keep getting faster, more capable, and cheaper:

- Recent revelations have shown the extent to which governments have used massive data storage capabilities to retain information about ordinary people, justified by the need to root out potential terrorists.
- And it's not only governments. People just going about their IT-enabled lives, such as shopping or planning travel on the Internet, have created vast troves of information about themselves that companies like Google and Facebook put to commercial use, yielding enormous revenues.
- Dramatic increases in processing power have enabled artificial intelligence to make commercially viable inroads into tasks like plagiarism detection, face recognition, language translation, speech recognition, and finding spoken words "of interest" in recorded conversations.[9]

It is easy to describe the advantages such capabilities provide, but it's sobering to think about their potential downsides. For example:

- Cheap digital storage means that information can remain accessible forever. While that can be useful for historians and biographers, it also means we can be haunted for life by an embarrassing picture, a bit of writing, or even something we said that got recorded.

- Sophisticated search algorithms are also invaluable for historians and biographers, but they can enable people in authority to ferret out and destroy information, erasing inconvenient history.[10] Webpages disappear without a trace unless someone makes a screen shot of them.
- GPS technology and smartphones enable people to be tracked. This is helpful for responders to an emergency, but it could enable highway patrols and car insurers to levy fines and rate increases every single time we exceed a speed limit.
- A highly integrated intelligent network can make many things more efficient (e.g., toll roads and power grids), but near-total dependence on a digital infrastructure (banks, etc.) helps criminals profit and cyber terrorists unleash havoc.
- A car computer connected to the Internet can speed up the response to a breakdown and maybe provide a diagnosis, but a malicious hacker could make the car stop or misbehave.[11]
- The ability to take quick photos and videos anywhere and anytime was instrumental in tracking down the Boston Marathon bombers, but it also enables gross invasions of privacy to live forever on the Internet.
- The smartphone/tablet/laptop allows us to carry out much of our work at home or in a coffee shop far from the annoying distractions of the office, but it also means we can be reached anywhere, anytime all too easily. The technology that allows this threatens employers with data theft and sabotage, while Internet connections facilitate goofing off during normal working hours.
- Real-time staffing optimization threatens employees with a life of unpredictable on-call work for which they must remain available, reflecting the current imbalance of power in lower levels of the job market.

A REAL BACKLASH THIS TIME?

This round of concern about possible downsides of new technologies may be more than just the latest example of misguided Luddism. Some backlash is not just potential but likely, and it behooves the IT community to at least recognize the possibility and take actions that would mitigate it. Consider the following:

- The new and better jobs may not appear as they always have, or they'll appear in a different country. We should not assume that global corporations will care about this without some financial incentives to do so. The hollowing out of the middle class has been going on for at least three decades and has finally become a political issue in the US, where it is most pronounced.
- Privacy has in effect disappeared. We cannot assume that self-policing will be effective in preventing businesses from misusing or carelessly treating data on employees and customers.
- Governments should not be considered invulnerable to the temptation to misuse data on their citizens, once collected, with overzealous "zero tolerance" law enforcement or the kind of police state a great many European adults do not remember fondly. (See the sidebar "East Germany: What If?")
- To argue that because so many millions have willingly shared huge amounts of very personal information means privacy won't be an issue is to bury one's head in the sand. Not everyone shares profusely, and there's often no choice whether to do so as it becomes harder and harder to participate in today's economy without divulging more than we might like. Ugly incidents could turn people off their openness only to find out how difficult it is to become "forgotten." "Revenge porn" and other kinds of personal threats over the Internet are becoming an issue with high potential to turn people off technology.
- To suggest that people with nothing to hide should not worry is specious. After all, what's worth hiding can change. A German in the 1920s may not have thought his Jewish ancestry was something to keep hidden even from friends, since officially sanctioned anti-Semitism had been abolished there for decades.

EAST GERMANY: WHAT IF?

The East German Stasi may have been the most developed police state enforcement organization ever, with its armies of spies and informers. Of course the apparatus had to be highly labor-intensive, given the technology of the day. The excellent German film *The Lives of Others* (2006) portrays this in fictional form, where the human decency of one professional snooper showed the ultimate weakness of the system. But if the Stasi had had today's technology ...

MINIMIZING THE BACKLASH

The IT community has a huge stake in minimizing the probability and severity of any backlash. One major asset is that their executives are, on the whole, more publicly respected than their counterparts in most other industries. They have bully pulpits that they can and should use to get in front of both technical and broader sociopolitical issues likely to bring on or intensify backlash. The most critical technical issues are security and privacy. The most critical sociopolitical issues are education and income inequality. There are also two philosophical issues — 100% consistency and 100% optimization — explained below.

Technical Issues

It has become difficult to get through more than a few days without news of yet another security breach. Cyber crime, cyber mischief, and cyber terrorism are no more 100% preventable than more traditional misbehavior, but that does not excuse anything other than giving top priority to *security* of both data and critical infrastructure. Say some nightmare scenario were to materialize. It would be a disaster for the industry if people lost confidence in the Internet, no matter how reasonable the excuse. Software and hardware designers need to become obsessed with security.

As the people who can best comprehend the possibilities for their handiwork, members of the IT community need to address the *privacy* issue proactively, pressing governments not to "get out of their way" but rather to work with them to establish practical policies and laws that ensure that the spirit of legal protections for ordinary people (such as in the US's Bill of Rights) pervades a society surrounded by 21st-century technology. Google's early motto of "Don't Be Evil" needs to be enhanced with "Don't Do Evil" and become the industry's motto. Europeans have given this far more thought. Their Data Protection Directive[12] goes back to 1980, and a new framework has just been agreed.[13]

Sociopolitical Issues

As already mentioned, new technologies are not kind to people who lack the knowledge and skill needed for more mentally demanding jobs. When lots of non-mentally demanding jobs vanish, as they have throughout the rich world, even as primary and secondary schools continue to turn out too many barely literate or numerate graduates, the state of *education* in much of the rich world (and certainly in the US) constitutes an issue of national self-preservation. Leaders in the IT industry need to become very publicly vocal about this and should devote a portion of their often fabulous new wealth to philanthropies that fund innovative experiments and pilot programs challenging tradition and conventional wisdom.

Gross *inequality* of income and wealth has a destabilizing effect on societies, as more and more people feel they're in a rigged game. The US was more successful than Europe in resisting the appeal of various early 20th-century "-isms" because so many Americans were only a generation or less removed from deeply stratified Europe, and the American dream was credible and real. After World War II, both Europe and the US became much more economically egalitarian, as huge middle classes with rapidly improving living standards developed, offering a real chance for people born in the lowest income quintile to move to the highest. While technology and foreign competition have reversed this egalitarian tendency all over the rich world, the reversal has been most pronounced in the US. Minimum wages need to increase so that a person working full time will no longer be poor, and there needs to be strong disincentives to exporting jobs. When jobs do disappear, as some must, an honest effort is needed to help the people affected to adjust and adapt. IT firms can lead by example, paying even their humblest employees a living wage and insisting that their contractors do the same, as Facebook has just done.[14]

IT industry leaders need to be publicly vocal on this issue as well, in large part to offset the stereotype of tech executives living in bubbles, oblivious to the plight of those who can't play in their high-flying league.

Philosophical Issues

Computers are great at enforcing the rules they're given with *100% consistency*, leaving no room for judgment or common sense. But without that slack, life become oppressive. As all drivers know, not every infraction or deviation matters.

Computers are good at achieving *100% optimization*, squeezing out every last redundancy. But life without redundancy is too perilous. Tightly coupled systems are maximally efficient when everything works right, but expecting that disrespects Mr. Murphy.

The role of IT leaders here is to warn customers away from overcomputerization and to promulgate design guidelines that reflect this more humble philosophy.

SOFTENING TECHNOLOGY'S ROUGH EDGES

Psychologists and sociologists have expressed concerns about the effects all these wondrous new technologies will have on people — our attention spans, our ability to make truly meaningful connections with others, or our capacity to function as a society. (Try Googling "psychological effects of technology" to see what I mean.) It would be foolhardy to suggest that we dismiss their concerns, but the Carlyle quote cited earlier may put things in perspective. While his concern that humankind would become "mechanical in head and in heart" seemed legitimate and plausible in 1829, it did not happen. Perhaps human nature is too hardwired for any software to change it, at least for the worse. We can hope.

However, that glimmer of optimism must not deter us from recognizing that unless changes are made to soften the rough edges of IT-driven disruption, some backlash is not just inevitable but justified. We in the IT community can choose to lead these changes calmly and rationally, or we can take our chances with unpredictable and probably irrational public anger — to which politicians and courts will respond, not necessarily with calm rationality.

ENDNOTES

[1]Conniff, Richard. "What the Luddites Really Fought Against." *Smithsonian*, March 2011.

[2]Conniff (see 1).

[3]A Ford executive first used the term but applied it only to a narrow range of factory tasks.

[4]Originally published in 1952, *Automation: The Advent of the Automatic Factory* was reissued by American Management Association in 1983.

[5]The folksinger Phil Ochs released "Automation" in 1964 as part of his *All the News That's Fit to Sing* album. Lyrics can be found at www.metrolyrics.com/automation-song-lyrics-phil-ochs.html.

[6]Wikipedia tells us this law was "articulated by Cyril Northcote Parkinson as part of the first sentence of a humorous essay published in *The Economist* in 1955; it was reprinted with other essays in the book *Parkinson's Law: The Pursuit of Progress* (London: John Murray, 1958). He derived the dictum from his extensive experience in the British Civil Service."

[7]Preston, Julia. "Pink Slips at Disney. But First, Training Foreign Replacements." *The New York Times*, 3 June 2015.

[8]Durbin, Dee-Ann. "Mercedes vs. Google: How Two Competing Visions Are Racing to Bring Driverless Cars to Market." The Associated Press, 10 July 2015.

[9]One wonders, have Egyptologists had to find a substitute name for the goddess Isis?

[10]Using paper, scissors, and a "memory hole," making history disappear was the job of Winston Smith, protagonist of George Orwell's novel *1984*, written in 1948. How's that for 67 years of progress?

[11]Greenberg, Andy. "Hackers Remotely Kill a Jeep on the Highway — With Me In It." *Wired*, 21 July 2015.

[12]"Data Protection Directive" (Wikipedia).

[13]Gibbs, Samuel. "EU States Agree Framework for Pan-European Data Privacy Rules." *The Guardian*, 15 June 2015.

[14]Zillman, Claire. "Facebook Is Wading Into the Minimum Wage Debate in a Huge Way." *Time*, 14 May 2015.

Paul Clermont is a Senior Consultant with Cutter Consortium's Business Technology Strategies *practice. He has been a consultant in IT strategy, governance, and management for 30 years. Before going into individual practice, Mr. Clermont was a Principal with Nolan, Norton & Co., a boutique consultancy that became part of KPMG. His clients have been primarily in the financial and manufacturing industries, as well as the US government. Mr. Clermont has spoken and written and taught executive MBA courses on the challenges of getting significant and predictable value from IT investments. Before joining Nolan, Norton & Co., he directed IT strategy at a major Boston bank and launched its IT executive steering committee. His undergraduate and graduate education at MIT's Sloan School of Management was heavily oriented toward operations research. Mr. Clermont is based in San Francisco and can be reached at pclermont@cutter.com.*

Temporal Stakeholder Analysis of Future Technologies:
Exploring the Impact of the IoV

by Carl Adams, Amanda Peart, Penny Ross, and Benjamin Aziz

MAPPING THE FUTURE

Rowan Gibson, a strategy consultant with the Rethinking Group, argues that we are going through an unprecedented level of technological change, which is forcing businesses and society to continually reassess their current state and rethink how they manage their place in the future world. Gibson argues that some action and forethought is needed, as "the lesson of the last three decades is that nobody can drive to the future on cruise control."[1]

That said, it is problematic to try to guess where future technology will take us, as Bernd Stahl, director of the Centre for Computing and Social Responsibility at De Monfort University, notes:

> Briefly, we can know neither future information technology nor any of the other aspects of the future. At the same time, however, we need to make decisions based on assessments of the future that will then, in turn, influence the way the future will turn out in practice.[2]

A further problem is that technology and the people who use it often have a habit of surprising us. People use technology in unexpected ways, business and social processes change in unexpected ways, and the technology enables new sets of users to emerge — again using the technology in ways it was not designed for. Michael Arnold of the University of Melbourne, Australia, cites auto safety measures as one example of the paradoxical nature of technology. Automakers improved car brakes in order to make driving safer; however, having improved brakes on a vehicle often causes drivers to change their behavior, such as driving faster and closer to other vehicles. This reduces the "thinking" component of stopping time and, consequently, can make driving more dangerous.[3] Another example Arnold cites is antibiotics, which were developed to kill pathogens and reduce disease. However, their success led to overuse, which in turn has resulted in pathogens evolving into resistant strains that limit the effectiveness of antibiotics.[4]

Some prior consideration of the impact of these technologies might have prompted the parties concerned to take steps to reduce the potential risks. In the case of the improved brakes, automakers might have developed complementary vehicle technology, such as proximity-sensing and warning systems. Medical policymakers might have encouraged more sparing use of antibiotics rather than treating them as a panacea for all ailments.

As the above examples show, we are in a Catch-22 situation. While it has become increasingly important to consider the potential impact of future technologies and plan for opportunities and risks, it is difficult to predict what technologies will become dominant, how people will interact with them, and what corresponding risks may emerge. Business and societal leaders need practical tools to help with this exploration in order to avoid unexpected technology backlash.

TOOLS OF THE IMPACT ASSESSMENT TRADE

There are many tools and techniques for exploring and investigating the impact of technology, and evaluations are often performed as part of the risk assessment process, such as those recommended by the standards bodies. For instance, the ISO 9001/3 and related ISO 31000 provide guidance on conducting risk assessments and managing risk that explicitly covers assessing risks associated with technologies (although their focus is, admittedly, on the adequacy of current controls within an organization). Here we outline some of the technology assessment methods currently in use.

Participative Technology Assessment

One main theme in most forms of technology impact assessment is the involvement of different experts and stakeholders. For instance, Stahl suggests using Participative Technology Assessment (pTA) methods,[5] which incorporate early thinking on technology assessments developed in the 1960s by the US Office of Technology Assessment, but also include consideration of more socio-technological issues and the involvement of multiple stakeholders. A key benefit of using a

participatory process to capture the views of multiple stakeholders is that it can help its users develop pragmatic perspectives on how a technology may evolve, such as who would use it, how they would use it, and what clashes of use between different stakeholder groups might arise. It can also help practitioners identify possible risks and dangers of various technological options and so determine those that should be encouraged and those that should not.

When assessing technologies that are not yet available, it is not always clear who the full set of stakeholders is likely to be. However, it is still useful to contemplate the possible impact of the future technology, including identifying potential stakeholder groups that *could* be affected.

Future Analysis

The Future Analysis (FA) assessment tool, which addresses the dynamic nature of requirements in ICT, likewise uses a multidisciplinary team to identify possible changes in a system. Developed by Frank Land[6] of the London School of Economics and Political Science, FA classifies the potential areas for change into major categories of technology, legal requirements, economic/environmental factors, and attitudes and expectations within the organization. It also develops a basic scenario of the future to try to assess the kind of future the ICT would have to face. The output, Land claims, is a prediction of possible scenarios and greater insight into the dynamic environment of a new ICT development.

Scenarios and Use Cases

The scenario approach has been widely used to assess possible future operating environments for businesses, industries, and society.[7, 8] "General" future scenarios are used to capture likely large, structural changes. Sometimes more depth is needed, so the general scenarios are used as the base for developing more specific use cases that detail instances of a particular use of a technology in a particular context. Having more detailed scenario use cases helps evaluators consider and analyze specific uses in more depth, enabling a better understanding of how stakeholder groups will engage with the technology.

Temporal Stakeholder and Event Analysis

One approach that explicitly brings together the scenario/use case aspects, the involvement of different experts and stakeholder groups, and a temporal element (looking backward and forward) is Temporal Stakeholder and Event Analysis (TSEA).[9] TSEA draws upon the experiences of different stakeholder groups with previous technologies and applies that learning to a new technology or system. In this way, it provides a structure to capture the lifecycle of a technology/system and how it impacts stakeholder groups at each of the lifecycle stages.

TECHNOLOGY ASSESSMENT IN PRACTICE

Our Method

In the remainder of this article, we present and demonstrate a practical method we used to help assess the impact of a future technology on key stakeholder groups. The method is an impact assessment based around workshop sessions in which expert participants develop scenarios and detailed use cases of how a new technology could be used in real situations. The workshops use a temporal frame, looking back at previous similar technology introductions to briefly evaluate their lifecycle and how they impacted various stakeholders, as well as capturing any extended or unexpected uses of the original designs. This information is then used to help extrapolate how the new technology could affect stakeholders, exploring the wider impact and possible unintended consequences over the lifecycle of that new technology.

When assessing technologies that are not yet available, it is not always clear who the full set of stakeholders is likely to be.

We then demonstrate our impact assessment method by presenting the results of two workshops that explored the possible adoption of the Internet of Vehicles (IoV). The workshop sessions produced some interesting results that challenge some of the common value propositions that are being used to promote the development of the IoV.

Our Three IoV Use Cases

Use case examples are a good way to show how such an analysis of a future technology can be conducted. As noted, the future technology that we are considering is the IoV within the larger Internet of Things (IoT), an interesting set of technologies on the horizon that will have significant and far-reaching impacts on how societies function and interact.[10, 11] The scale of investment

around the globe in the IoT and IoV is considerable, and many of the building blocks are already here.[12] For instance, at the *Consumer Electronics Show (CES)* in Las Vegas in January 2015, many of the car manufacturers from the US, Europe, and the Far East showcased their latest developments, including autonomous drive technologies and car-to-car communication systems.

There are many technical, business, and practical challenges in getting these very complex systems working to achieve the expected efficiencies and promised benefits — and this has been the focus of most IoT research and investment.[13] The IoV will probably be one of the most evident manifestations of the IoT for many people, with changes coming from a variety of factors, such as: environmental imperatives (the need for more efficient travel, higher vehicle density on road networks, reduced pollution, etc.), technological changes (driverless cars, more automation in cars), safety (accident reduction), and business advantage (having more reliable transport systems for delivery of goods and employees).[14, 15]

Based on these and other strong value propositions given for the IoV,[16, 17] we defined three distinct, detailed use cases to assess the potential impact of IoV adoption.

There are many technical, business, and practical challenges in getting these very complex systems working to achieve the expected efficiencies and promised benefits — and this has been the focus of most IoT research and investment.

Use Case 1: Automated Commuting Convoys and the Resulting Hours of "Extra" Time

A result of automated commuting will be that people will have "extra" time that was previously used to drive their vehicles. Commuting time can be considerable;[18] for many workers around the world, it amounts to an hour or more each way.

Use Case 2: Convoys Coordinating the Crossing of Road Junctions

This use case explores how the convoys/road trains will coordinate the traversing of road junctions so that vehicles don't need to stop. It also covers efficiencies in travel such as reduced air resistance in close-packed convoys.

Use Case 3: Handling of Road Disruptions

This use case covers breakdowns or obstacles on a road and how an autonomously driven vehicle would work out how to most effectively get around the obstacles. The main value propositions here relate to journey resilience (consistent road journeys, ability to handle disruptions and emergency situations, less stress for commuters and travelers, betters supply chains, etc.).

Our Workshops

Having developed the detailed use cases, we then critically evaluated them at two workshop sessions. To bring out more detail for each of the use cases, we asked the following questions about the likely application of the technology:

- How would each of the stakeholders interact with the system?
- How could communication be organized?
- Which entities would have responsibility for control of which parts of the system?
- Who would pay for what?

The workshops followed a mini living lab approach where ideas were raised, discussed, evaluated, and developed in small groups; the resulting ideas and issues were then combined together for a whole group evaluation. Each workshop consisted of 20-30 participants, including two groups of final-year students at the University of Portsmouth, one group in a highly technical computer science degree program and the other with a technology management focus. Academic staff with technology and management expertise also participated. Approximately 50% of the workshop participants were drivers. Part of the workshop activity was to consider and evaluate options from technology, practical, and business perspectives.

Participants were divided into groups of three to five people, and each of these small groups considered the detailed use cases and associated questions. They were also encouraged to "think outside the box" and develop their own questions on how the technology would be used and how it would impact wider stakeholder groups. The emergent discussions were captured by each group, typically on a large sheet of paper, sometimes supplemented with Post-it Notes, though some groups also used electronic recording. The themes and discussion points were collated together at the end of the workshop with final discussion on the points and issues raised.

Afterward, the raw themes, discussion points, challenges, and so on, collected from both workshops were hosted electronically so participants could view them and add further comments and feedback on the emergent issues. The team then collated the results of the emergent themes to develop a more thorough analysis for a report on the potential impact of IoV.

THE RESULTS

As we discuss below, one of the main results of our workshops was that for each of the use cases, participants uncovered a set of issues that challenged the value propositions used to promote IoV/IoT activity (e.g., improved commutes, reduced traffic jams, increased safety).

Use Case 1 — Automated Commuting

During the workshop discussions, three main commuter profiles emerged:

1. Worker-commuter
2. Social-commuter
3. Entertainment-commuter

There would likely be variations within these categories (e.g., different types of worker-commuters), and individuals could fit multiple profiles (e.g., sometimes a worker-commuter, sometimes an entertainment-commuter). The basic profiles are described in greater detail below:

The Worker-Commuter

This profile represents employees who use the commuting time for business activity, with the self-driving vehicle acting as a fully functioning traveling "office" space. This possibility prompted several discussions on how this would work in practice. One concern was that it would evolve into commuters being forced to extend their working time and environment to include the extra commuting activity, effectively resulting in employers getting more work out of their employees for no additional compensation. Alternatively, it could shorten the commuters' workday if they count the commuting time as valid work time. In such a model, the actual time spent commuting wouldn't be relevant to the efficiency of businesses, since employees could be productive at work or in the commuting state. So from a work perspective, it would not (necessarily) be a problem to be stuck in a long traffic jam; indeed, for some employees, being struck in traffic may enable them to be more focused on work activity than in the office environment.

Some participants observed that if the concept of the fully functioning traveling office were extrapolated, then some employees could dispense with the commute altogether and just work from home using their new "office space," be it in their vehicle or their home. The unintended consequence here was that having more technology to help the commuter get to work quicker and more easily may actually reduce the need for commuters to *get* to work. Where a faster commute is the primary goal, workshop attendees suggested that low-tech alternatives, such as coordinating commuting times to ensure minimal congestion (say, by changing the start and end of employees' workdays) might be just as or more effective.

The Social-Commuter

Workshop participants also considered what would happen if employees used an automated commute for social space and purposes. This raised many ethical and privacy issues regarding how people would use that social space and extra time, as well as the potential for misuse by other commuters, marketers, technology companies, and governments. After all, commuters will be trapped in a confined space, very much a captive audience, with much personal data being shared between vehicles and road furniture, such as journey details, insurance data, address information, passenger details, entertainment preferences, and so on.

Another issue that emerged in the discussions was the potential changes in social behaviors that may ensue. For instance, with people confined in a private space with free time on their hands, would we see the emergence of driverless commuter dating?

The Entertainment-Commuter

Alternatively, commuters could use the commuting time to watch a movie, listen to music, or eat breakfast. Clearly, we would see the emergence of new commuter-based business models in which marketers would look to cater to the preferences and needs of commuters with extra time on their hands. The potential for several unintended consequences was clearly evident in the discussions. The safer commuting originally envisaged by IoV proponents may turn into unsafe social practices, new avenues for security and privacy breaches (e.g., misuse of personal journey data), and new types of safety risk (e.g., increased risk of choking on or spilling hot food while eating breakfast in a moving vehicle).

Use Cases 2 and 3 — Coordinating Convoys at Road Junctions and Handling Road Disruptions

For the other two use cases, the discussions raised several issues around how coordination of autonomous vehicles would actually work in practice. For instance, participants noted that there would likely be different priorities for different types of vehicle traffic, such as high priority for emergency vehicles. Different types of vehicle convoys, say trucks and cars, may have different traveling capabilities, which would need to be factored into any coordinating methods. Discussions emerged around how to coordinate convoys of vehicles each with different capabilities, preferences, and priorities (e.g., some convoys may place a priority on quick journey time while others focus on economy).

Clearly, there would be some negotiation required between convoys to find the best coordinating option for traversing a junction or road disruption. Workshop attendees discussed the potential for paying for increased priority and, further, for "gaming" activity between convoys (i.e., attempts to get preferential treatment for a particular convoy). One possible unintended consequence discussed was that "better" coordination would likely not be applied equally to every set of road users, and thus we could see a different type of road rage emerge.

Much technological development is blinkered by a technological mindset that focuses on the innovation itself; the impacts and unintended consequences of a new technology are not considered until the technology is already with us.

WORKSHOP LESSONS LEARNED

The workshops, which were focused around a detailed set of use cases within a general IoV/IoT scenario, uncovered issues that policymakers should consider before the technology progresses too far. Clearly, the challenges of IoV/IoT are not purely technical, and the impacts of the technology might not be those initially intended. The two workshop sessions captured critical perspectives that contested the value propositions often presented in the literature and reports covering IoV/IoT (e.g., that it will be safer and more resilient).

What Worked Well

The workshop approach using the living lab evaluation cycle, with opportunity for continued feedback and discussion of emergent themes, seemed a good way to conduct a technology evaluation using one of the participant/stakeholder approaches. It was quite cost-effective and produced timely results.

The temporal stakeholder analysis (looking backward at past technology and forward to similar patterns with new technology) within the workshop format likewise seemed to work well. Having groups with distinct expertise (technology and business; drivers and non-drivers) encouraged a wide-ranging analysis that yielded multiple perspectives. Both workshops generated many issues and points that require further investigation (more consideration of what people will do in self-driving commuting vehicles, their loss of personal control while in the vehicle, who pays for the road communication services, etc.).

What Could Have Worked Better

On reflection, it would have been good to record the live discussions, which were often quite rich as participants considered the implications of a particular use case. Similarly, it would have been useful to hold a follow-up workshop with the participants to further explore some of the interesting issues raised, possibly with representatives of other stakeholder groups identified during the initial workshop sessions. For the participants in our study, we drew upon final-year graduate students supplemented with academic staff. Including different groups of participants may well have resulted in other issues and options emerging.

EVALUATING FUTURE TECHNOLOGY: WHEN? HOW OFTEN?

It is unclear how often such evaluations of future technology should be conducted. The Canadian *Privacy Impact Assessment* guidance recommends that government departments conduct a "PIA in a manner that is commensurate with the level of privacy risk identified, before establishing any new or substantially modified program or activity involving personal information,"[19] or specifically when there is new technology, substantial modifications to a system, new processes, or new uses of a technology. In addition to these scenarios, the guidance from standards frameworks suggests that risk assessments be done as a rolling scheduled process, say as part of the internal audit process (and, of course, as part of the standards accreditation process).

We believe that it is useful to do an assessment before a new or future technology is introduced. Much technological development is blinkered by a technological mindset that focuses on the innovation itself; the impacts

and unintended consequences of a new technology are not considered until the technology is already with us.[20] Furthermore, technological change only seems to have "forward gears" — once a technology has been adopted, it is difficult to go back to a previous state or steer the direction of technological evolution down a different path. However, with a forewarning of issues and problems, it *is* possible to influence the direction of the development of technology early on, taking into account affected stakeholders and the wider community.[21] Our common future deserves no less.

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Carl Adams is a Principal Lecturer/Researcher in the School of Computing, University of Portsmouth, UK. He had over a decade of professional experience as a software engineer, analyst, and consultant before going into academia. Dr. Adams's research interests explore the wider impact of the digital economy and include e/m-commerce, e/m-government, mobile information systems, social media, electronic money, and the impact of technology on society. He has over 100 peer-reviewed publications in journals and international and national conference proceedings as well as several book chapters and a book. Dr. Adams has been a keynote and invited speaker at conferences and workshops. He can be reached at carl.adams@port.ac.uk.

Amanda Peart is a Senior Lecturer in computer science within the School of Computing, University of Portsmouth, where she predominantly researches and teaches in computer networks at all levels in the undergraduate program. Dr. Peart has held a variety of external examiner appointments for a number of universities. Her main area of research is the quality of service (QoS) in ad hoc wireless networks. Dr. Peart's research investigates techniques that provide a satisfactory balance for applications continually demanding higher bandwidths while the users demand better QoS in wireless environments with bandwidth, delay, jitter, reliability, and power challenges. She can be reached at amanda.peart@port.ac.uk.

Penny Ross has been a Senior Lecturer in information systems at the School of Computing, University of Portsmouth, for seven years. Dr. Ross's teaching areas are information systems management and advanced database concepts (for final-year students), while her main focus is in applied uses of information and information systems. Her research topics have covered a broad range of environments, but the underlying core is analysis, understanding of complex systems, and the application of IS within these environments. Other projects include working with a city council to develop telecare systems to support the vulnerable and elderly within the city and evaluating the principles and procedures for development and implementation of a mobile telecare service. She can be reached at penny.ross@port.ac.uk.

Benjamin Aziz is a Senior Lecturer in computer security at the School of Computing, University of Portsmouth. Dr. Aziz holds a PhD in formal verification of computer security from Dublin City University and has research experience in the field of computer and information security spanning 15 years. He has worked at Rutherford Appleton Laboratory and Imperial College London and has published more than 80 articles and book chapters in areas related to the security of large-scale systems, formal security, requirements engineering, and digital forensics. Dr. Aziz is on board program committees for several conferences and working groups, such as ERCIM's FMICS, STM, Cloud Security Alliance, and IFIP WG11.3. He can be reached at benjamin.aziz@port.ac.uk.

Cool, Not Creepy: Avoiding IoT Backlash by Respecting and Educating Your Customers

by Annie C. Bai

"'We'll see,' said Calvin. 'The robot may prove too valuable to dismantle.'"[1] These words of the legendary Dr. Calvin — the fictional chief robot psychologist in Isaac Asimov's revolutionary *Robot Dreams* short stories — underlie our contemporary trepidations. We are at the cusp of an era in which connectivity is no longer limited to computing devices but expansively includes more and more everyday networked objects: an era already known as the Internet of Things (IoT). If we do not trip over our fears, the upcoming decade will usher in a new world of highly useful and valuable objects. Greater technologies will also lead to our dependence upon those technologies. In plainer terms, the point of creating cool stuff is to make people want and need the cool stuff.

Ultimately, however, Dr. Calvin felled the dreaming robot with a gunshot, proving that no value is too great to dismantle if it triggers our visceral fears. Heed my words: if you want your cool stuff to stick around, then do not ignore the possibility that it will elicit a fearful response. Do not stick your head in the sand when it comes to privacy protections. Deal with them from the get-go and spare yourself publicity like this CNN headline: "Your Samsung TV is eavesdropping on your private conversations."[2] Either don't invent a robot that can dream, or market the hell out of it so that everyone knows that the robot dreams, is OK with the dreaming, and actually wants to buy a dreaming robot.

Technology backlash is as old as technological innovation. It is inevitable that people will grouse about new technologies and adopt them with varying degrees of acceptance. Yet, with one caveat, the cool stuff will take hold and prevail on the basis of its functionality and actual worth to people. The caveat is that this will happen only if these products do not give people some absurd reason to do a double-take and say, "What? You didn't tell me this amazing product" — and here, take your pick — "uses triangulation to share my location with perverts," "shares my aimless meandering around department store aisles with marketers," "leaves my television camera running," or "records my child babbling away to a beloved toy."

Nowadays, it is the vogue to be reactionary, to make grand statements such as deleting one's Facebook profile or starting a Google bus protest. This article concerns itself with a particular type of reaction to the Internet of Things — that of consumers who avoid buying cool products because of privacy-related fears. My advice for overcoming this resistance is twofold: avoid *infamy* and *bridge the gap*.

AVOID INFAMY

The first guiding principle is to *avoid infamy*. Privacy invasions are a hot topic and are often presented in an inflammatory manner by the media. Where one used to accrue cachet for being "in the know" about the latest and coolest tech products, there is now a perverse prestige in *refusing* to buy into the latest and coolest because one is in the know about privacy. Folks nowadays regale dinner companions with all the creepy ways in which corporate America uses and misuses consumer data. Everyone has a favorite scare story — be it Facebook-sponsored stories, toys that listen to your kids, Samsung televisions with an open camera feed on your family room, and more. My favorite is the hacked baby monitor that started speaking (the white hat hacker's voice) in a baby's room. Trust me, it makes for good dinner conversation.

There are many ways in which companies can reduce the risk of ignominy by being proactive. On the production end, it is invaluable to invest in vetting products for privacy hiccups or security gaps before they hit the market. Here, take note that privacy and security are not the same creature. Privacy refers to consumer-facing practices — what you do, don't do, will do, and promise to do or not do under certain circumstances — that affect people's personal data and their identifiability by third parties. Security refers to the protection of corporate assets (including data on customers) and

systems; this includes a risk management program and technology policies in addition to actual security measures. On the consumer end, it is vital to keep an open mind while keeping an ear to the ground to really understand consumers' reactions to connected products. Companies that lack sensitivity to their customers' anxieties and needs will be culled from the rest — and often in a very public manner.

Acknowledge Privacy Fears

First off, IoT executives and managers need to heighten and even reset their awareness of the myriad ways in which privacy affronts can bring down a business. At this point, there is plenty of rhetoric about consumer privacy. Yet there are still indications that executives remain smug on the issue. A recent Deloitte study depicts the disconnect between corporate complacency and consumer expectations. Whereas execs feel that their corporations are behaving better with regard to privacy and data security, consumers are having the exact flip experience:

- 77% of executives surveyed believe their companies' data privacy policies are clear and well-understood by consumers, while roughly 73% of consumers say they'd like to see more easily understandable data privacy policies from companies.
- 47% of executives believe consumers regard the risks of sharing their personal information as worth the personalized promotions, advertising, or coupons they receive from [consumer product] companies in return, yet only 25% of surveyed consumers agree.
- 47% of executives think consumers view the risks of sharing personal information as worth the product recommendations they receive from [consumer product] companies, yet only 18% of consumers say the same.[3]

Name a Privacy Point Person

Second, there needs to be a leader on the privacy front, someone who is persistent in the face of apathy. Privacy is often perceived as a mere compliance roadblock. Security is typically regarded as a necessity, but employing security tools without regard to the human angle is ineffective. Human error causes a significant percentage of data breaches, misguided product development often leads to privacy snafus, and there is plenty of room for mistakes in this unregulated sector. The security defaults are insufficient when they themselves were set by technologists of a pre-IoT era. Many companies might give lip service to privacy, or even have an authentic regard for privacy and security. However, scattered interest will not get the job done. Every movement needs a leader, someone to corral all the stakeholders and push the needed conversations to the fore. The privacy point person must be an advocate, a proponent, and an administrator who has the authority to raise these issues and push privacy conversations through to completion. He or she needs the backing of the executive level and buy-in from the security staff. This person may be a chief privacy officer, a chief information security officer, or any other leader willing to champion the cause.

Companies that lack sensitivity to their customers' anxieties and needs will be culled from the rest — and often in a very public manner.

At Single Stop, where I am privacy counsel for a data-intensive and tech-driven nonprofit, I work hard to get all of our departments to reach out to me and engage in conversation with regard to the privacy of our clients and security of our systems and processes. It starts with an outstretched hand and an open invitation to talk. For example, I developed a privacy impact assessment (PIA) report, but rather than put the onus on staff to do the paperwork on subject matter that is new to them, I rolled it out by asking around about new projects and offering to fill out the PIA for folks. It's like saying, "I came up with a new compliance hurdle, but I'll take the first jump for you." I have found that in this situation, program and product developers are more willing to be up front about their product's implications for personally identifiable data, privacy, and confidentiality. It is critical to identify these issues beforehand, because then your product developers can bake in the privacy protection rather than spreading it on like frosting after the fact. Frosting is attractive, but it is also easily smeared off. Conversations can lead to actual product changes and implementations that have a significant impact on preventing privacy fiascoes or backlash.

Take Action

If you can surmount the hurdles of getting folks from the top of the organization to the bottom to talk about and participate in privacy conversations, the next step is to operationalize this work. A privacy program consists of regular risk assessment exercises and a structure for issue spotting and processing concerns and complaints. A privacy program does not require many full-time employees (or even one). An attorney or compliance manager can recruit stakeholders from throughout your organization to participate in a privacy awareness and protection committee. Staff may be assigned additional

responsibilities to keep an eye on privacy issues and support the dedicated staff. Internal promotion of education and security reminders goes a long way. I prefer to leverage the use of internal staff rather than relying upon an external consultant to muster up this kind of participation.

Mass consumption of technologies that are intimately involved in our lives will certainly lead to a backlash if consumers feel betrayed after spending their dollars inviting these products and companies into their homes.

BRIDGE THE GAP

As economists understand, expectations drive the economy. Consumers rationally expect that certain products (such as toasters) will not undertake certain actions (such as recording video of your kitchen activities). That was an extreme example — I hope — but it is vital to think ahead to the expectations that your product will elicit. Consumers vary widely in their awareness of the issues, technical ability to adjust privacy settings, and interest in being proactive about privacy. Expectations are based upon a person's experiences and knowledge, so it behooves us to consider the full range of expectations down to the lowest common denominator.

The Internet of Things presents consumers and businesses with a candy store of technological offerings to ease their lives and operations. However, these sweets are virtually unregulated and are built on a foundation of esoteric privacy surveillance and data-collection practices. The offerings are outpacing the education and information required to aid consumers in making knowledgeable decisions about them. The reach of technology is deeper and more potentially invasive than ever, and these cool products should be offered concomitantly with education and real-world partnerships rather than shrouding mysterious tech within a slick polyurethane case.

Mass consumption of technologies that are intimately involved in our lives will certainly lead to a backlash if consumers feel betrayed after spending their dollars inviting these products and companies into their homes. A customer who indulges her sweet tooth does not expect that the candy will cause her skin to break out in tattoos, just as customers of Aaron's Inc., the electronics rent-to-own retailer, did not expect their rental items to come in "Detective Mode" that would monitor their keystrokes and covertly activate their webcams.[4] That is a negative kind of example. But what if your candy is better than just a confection? What if it also has healing and nutritional properties? In addition to easing the chores of driving and navigating, self-driving cars may save a significant number of lives. Technology is no longer just a tool, but a way of life. People need to understand that they are eating a new kind of candy — one with deep and unexpected implications in their lives. It may come with sketchy ingredients like real-time monitoring, but also awesome ingredients like decreased accident casualty rates, lower energy bills, and insurance discounts.

I hesitate to use the buzzword "transparency" at this point, although that is what we are discussing. Transparency, as a concept, has failed. Companies all have a privacy policy and terms of service on their websites and apps. Policymakers make a big deal about consumer disclosures such as privacy labels, short form privacy policies, and terms of use agreements. But who reads them? And who understands them? Projects such as Terms of Service: Didn't Read[5] are commendable, but who will use them? It's still the people in the know. The concept, as it is currently operates, is esoteric lingo to the typical consumer. If you stopped ordinary pedestrians on the street and queried them about *transparency* in consumer tech products, how many people do you think would register understanding? The word "transparency" is, ironically, rather opaque.

Teach Your Customers Well

True consumer education is more than disclosure statements. It needs to extend to teaching consumers how to engage with technology with mastery and consciousness of surreptitious practices. When it comes to privacy, there is a widening gap between those with tech know-how and passive tech users. I see a parallel in current US national debates on economic parity and the haves and have-nots. The emotional current in America is relevant here because there is always an emotional element to widespread public backlash, be it against economic inequality or tech creepiness. A big plus in this case is that it should be easier to improve tech-savvy inequality than solving poverty and race inequality. Technology education has made strides in accessibility and quality, but it needs to keep pace with the next surge in product offerings.

There are two kinds of tech education that can make a difference here: one is the broad education of the general public, and the other is specific guidance for consumers of IoT products. To stave off a backlash against IoT technology, we must bring the public into the fold

by helping everyone become a "techie" to some small degree. Industry has the resources to offer free tech education to mass audiences: think Lynda.com meets Khan Academy. We are rapidly approaching a world in which as many people as possible need remedial education in the language of technology and privacy. For example, I believe that every online consumer should know how to inspect website source code to identify which cookies are being placed. Every consumer should know how to fiddle around with the settings in their IoT products. Every IoT product should come with an accessible privacy menu like the iPhone privacy settings, with as much detail as is appropriate for the product and its data uses.

Moreover, broad-appeal education programs must not be confined to the virtual world but should materialize as programming and partnerships in the corporeal world. Local libraries, town rec centers, and cafes are hubs where corporations and trade associations can leverage real organizations to push out education, training, and messaging to demystify technology and demonstrate its potential usefulness, yet invasiveness, in our private lives. Industry can engage with nonprofits such as the Electronic Privacy Information Center (EPIC) and the Future of Privacy Forum (FPF) to create campaigns to educate the public about how to optimally harness the benefits of cutting-edge technology. There is no reason for industry to have an adversarial relationship with such orgs when, in the end, transparency will lead to consumer empowerment and comfort. Privacy should not be a political issue. Cooperation between industry and consumer advocates can depoliticize this charged topic, because ultimately there is an alignment of goals here: creating cool stuff that people want to pay for.

In my utopia, all kids would be tinkerers using tools available at their playgrounds, all grandparents would learn how to Google Chat at their senior citizens center, all public libraries would host a Mini MakerFaire, and … all high schools would offer a class in sci fi literature. When I attended junior high school, they still taught auto shop, wood shop, and home economics. Those classes may have fallen by the wayside, but something should sprout up in their place. What about engineering classes and programming classes? What about combining both with LEGO Robotics toys?

NICE GUYS FINISH FIRST

Like cream rising to the top, companies that publicly embrace consumer education and empowerment will reap benefits in the marketplace. There is a role for industry self-regulation and, possibly, government regulation that could level the playing field for industry and ease the way for consumers. However, until that happens, we have before us a prime opportunity for IoT producers with integrity to distinguish themselves from the horde of data-collecting, location-snooping, vulnerability-ridden products.

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Annie C. Bai, CIPP/US, CIPM, is a graduate of NYU School of Law. She is Privacy Counsel at Single Stop, a national anti-poverty nonprofit and speaks on modern privacy law for New Directions for Attorneys at Pace Law School. She consults with for-profit and not-for-profits on privacy and data security on privacy audits in a variety of industry sectors. She can be reached at anniecbai@gmail.com; Twitter: @AnnieCBai.

Technology Backlash: Driving Factors and Preventive Measures

by Bala Somasundaram

When it comes to analyzing the unintended consequences of technology acceleration, it resembles a scenario often quoted in management guru Eliyahu M. Goldratt's book *Theory of Constraints*.[1] According to the scenario in an industrial context, it wouldn't help if the production unit alone runs efficiently and perfectly unless the sales and marketing department works at the same pace and clears the inventory. The idea here is not to pursue local unit-level optimization for productivity improvements and elimination of bottlenecks; that would only lead to excess inventory and increased costs. Instead, the company must consider and optimize the whole system, its parts, and their relationships/dependencies in order to improve the overall performance of the system.

Similarly, we live in times in which the technology industry is super-productive and works at an astounding pace to come out with innovative products that disrupt industries, one after another. Meanwhile, the rest of the pillars of society — be they economic institutions, governments, legal institutions, educational institutions, civic society, or the humanities — are straining to cope with the immense possibilities of the persistent technology innovations. The mismatch between the technological possibilities and our human/institutional capabilities for adopting and managing them can cause apprehensions in society.

FACTORS THAT COULD ENCOURAGE BACKLASH

The tension mainly arises from the confluence of the following factors:

- **The role of technology in fractal markets.** Geoffrey Moore defines fractal markets as a phenomenon in which markets get smaller and more granular around tighter and narrower demographics.[2] This happens when markets get out of a growth phase for a given category. For example, when a car market evolves through a growth period, it leads to the introduction of new specialized categories such as SUVs, minivans, and so on. Technology accelerates the pace of business cycles in general and the evolution of fractal markets in particular. This results in a rewiring of the configurations between market participants.
- **Growing adoption of digital technologies and automation in new and mature industries.** Starting with the domain of business processes, digitization and automation have evolved to empower the spheres of physical objects ("things") and human cognitive functions (artificial intelligence). This situation requires realignment of skills/capabilities within the business as well as in the open market.
- **The winner-take-all nature of the digital business model.** Successful early movers in digital business models can have a significant relative advantage over the late adopters, leading to uneven distribution of market opportunities.

These factors disrupt the configuration of business/economic models and shift the demand for and supply of resources (e.g., people skills, technology capabilities) in the marketplace fundamentally. When there is a discrepancy between the emerging digital business/economic models and the societal capacity, and it is left unmanaged, there is a risk of societal tension and backlash.

Technology in Fractal Markets

The industrial era was instituted on the principles of economies of scale and linear business growth, supported by a hierarchical progression of people's jobs. The hierarchical pyramid structure enabled the creation of progressive career paths that were manageable for businesses in a relatively less disruptive market environment. These tenets also led to the development of similar pyramidal social structures — predictable patterns of social relationships and social institutions that belong to a set of hierarchical classes.

However, all these assumptions are undergoing radical changes in recent times. Fractal markets theory, when interpreted from a technology perspective, can give interesting insights. Thanks to technology disruption and globalization, product standardization/optimization and market diffusion happen much faster when compared to the industrial era. This means a larger segment of global

customers can be served in a shorter span of time. Consequently, when a market gets out of its initial growth stage for the original product category, it creates a need and an opportunity for businesses to innovate and develop markets in smaller, niche categories that complement/differentiate the original product category. Technology not only helps to accelerate the likely business cycle of serving the core and innovating the adjacent segments, but it also provides the potential to disrupt and create a completely new cycle.

For example, in the car industry, the adoption of technology/platforms enabled automakers to introduce new and better models faster and more cheaply to global markets. The industry then evolved to introduce technology-enabled complementary services such as telematics/vehicle diagnostics. However, with the advent of such technologies as 3D printing and robotic vehicles, the car industry and its ecosystem participants (e.g., production and engineering employees, insurance providers, banking/financial services, governments, suppliers, consumers, support/repair services) all stand to reinvent themselves in terms of their role, value proposition, business model, skill/capability development, business model, and growth. This phenomenon is likely to happen not just in automotive/manufacturing, but several other industries such as financial services and healthcare as well.

When faced with technology disruption, industry participants would possibly respond in two ways[3] — making incremental changes or big-bang radical changes — to their existing business and operating models. The business model addresses the way in which a firm creates and captures value in its markets. The operating model defines the firm's organization structure, talent requirements, personnel roles and responsibilities, assets, technologies, business processes, and partnerships.

In the case of incremental responses, firms would make progressive adjustments to their business and operating models in the form of modular experiments and fine-tune them until they find the right model. In the case of disruptive responses, many alternative business/operating models could flourish and be adopted by the industry without any common governing pattern. This would bring extensive changes to industry participants — namely, the firm, employees, partners, suppliers, customers, regulatory authorities, and so on. The resulting changes could include many possibilities, such as a shift in market share across participants, obsolescence of certain functions, ambiguities in new models, and escalation of opportunities for a few sections or the need for regulation in others.

A society that is unprepared to respond decisively or experiment (i.e., take action in the face of uncertainty and iterate until the desired outcome is achieved) in the context of these changes could face backlash, as the disruption would unevenly impact the participants. For example, in Mexico, taxi drivers have protested[4] against technology-mediated ride service Uber. They claim that the playing field is not level, as conventional taxis are required to comply with legal requirements with which Uber is not required to comply. As discussed above, when technology disrupts an existing business model (e.g., traditional taxi services), society could respond in many different ways. In this case, the taxi drivers chose to protest, as they believed the taxi regulators didn't ensure a fair competitive environment for them when compared to Uber.

There is a general apprehension in society that automation will take away people's jobs.

Growing Adoption of Digital Technologies

The second significant factor that could potentially cause societal backlash is the growing adoption of digital technologies and automation of products/services and their impact on the workforce. There is a general apprehension in society that automation will take away people's jobs.

Until now, only information-intensive industries benefited from IT adoption. For example, the banking and financial services industries, media/telecom industries, and professional services industries (e.g. auditing/legal) embraced digital technologies to increase the efficiency and effectiveness of the services they delivered. However, with rapid technological advancements, digital technologies soon found adoption in traditional industrial/manufacturing industries as well as in support of higher-order cognitive solutions in service industries.

In agriculture, we can look forward to seeing the shift of production from electromechanical farm equipment to agri-robots. In the not-so-distant future, farmers could 3D print robotic parts and download crop-specific software from an algorithm marketplace over a cloud service provider. In this case, an industrial manufacturing company would transform into a software/robotics company. To take another example, traditional defense equipment manufacturing companies are acquiring capabilities to manage cyber security threats. Similarly, we can soon expect to see disruptions in other core sectors, such as healthcare (e.g., personalized medicine

enabled by genetics/analytics), oil and gas (e.g., use of drones in oil exploration and data collection), and aerospace (use of machine-learning technologies in remote machine condition monitoring and maintenance).

The extensive digitization of business processes, products, and services in the manufacturing and service sectors will require companies to look again at their internal workforce planning and capability development for the future. Unless educational institutions continue to anticipate the transformational needs of the industries and educate the future workforce in required skills and capabilities, there will be a significant gap in demand/supply of the workforce. Any potential imbalance in this demand and supply configuration could lead to underproductivity of the future workforce.

Industry consortiums, universities, and governments need to promote conditions for entrepreneurship that increase the size of the economic pie by creating new markets rather than just disrupting current ones.

As business models gets digitized, information/data becomes the primary means of communication and contracting across the participants. When all business capabilities including technology are democratized and equally available to market participants, data becomes a strategic asset and competitive differentiator for businesses across sectors. However, the gains of information ubiquity in business come with the risks of potential data breach. Unless a value-oriented management policy and robust preventive operations and recovery procedures are in place, data privacy breach is a possibility and could cause a breakdown of trust between businesses and their customers.

Winner-Take-All Nature of Digital Markets

The third biggest factor that calls for attention is the winner-take-all dynamics of digital markets. If the pyramid model represented the industrial economy, and fractals represent mature markets, then the winner-take-all dynamic looks to be the ruling tenet of the digital economy.

When we talk about the winner-take-all nature of the digital economy, what this means is that companies that are early movers in digital technology adoption have the opportunity to build a substantial relative advantage over late adopters and competing businesses. For example, an early mover to online retail can gather online customer data and leverage it to deliver new data services such as product recommendations. This can create a successful virtuous cycle of acquisition of customers, aggregation of data, generation of valuable insights, and launching of new products and services. This is turn can lead to the creation of huge barriers to entry for late-coming online retailers in term of acquiring and retaining new customers. This concentration factor serves to widen the gap between winners and others in the digital market.

Unless an organization identifies its relative position in the market and competes effectively, it will be at a disadvantage in gaining market share and expanding its business. Based on the relative position of the company (i.e., early winner or late entrant), the organization can choose to either make focused investments in successful ventures or disinvest or diversify into innovative new ventures. The strategic question to be asked is whether the organization and its people are prepared and have the ability to respond to winner-take-all dynamics with agility, resilience, and innovation. The absence of such capabilities could contribute to unequal opportunities and imbalances in society.

HEADING OFF BACKLASH IN THE SHORT AND LONG TERM

Managing job growth and market opportunities in the midst of technology disruption will require us to take several short-term and long-term measures.

One of the short-term antidotes could be to use technology and information themselves to bridge the gaps in job markets. For example, a June 2015 McKinsey report[5] analyzing the inefficiencies of the labor market recommends that improving online talent marketplaces such as Monster, LinkedIn, and the like, could boost global GDP by US $2.7 trillion. The report states that this could be accomplished by improving productivity and labor force participation through better and faster matches between labor demand and supply.

The first on a list of long-term remedies would be for mature industries to evaluate the impact of automation and evaluate and apply workforce management practices, such as job sculpting (i.e., shaping job descriptions in line with an employee's strengths, interests, and potential), job rotation, retraining, diversification, intrapreneurship/partnering, and open innovation. Industry consortiums, universities, and governments

need to embrace the new reality and promote conditions for entrepreneurship that increase the size of the economic pie by creating new markets rather than just disrupting current ones and reducing the share of existing participants. This includes identifying the toughest problems to be solved (e.g., cyber security), emerging societal needs (e.g., reducing urban congestion, promoting clean energy), and innovation opportunities, as well as designing incentives for R&D, facilitating inexpensive market entry for entrepreneurs, promoting experimentation and incubation, and helping to scale products and services.

While we celebrate and enjoy the benefits of a technology-moderated sharing economy that serves certain customer segments (e.g., Uber, Airbnb), we also need to expand the markets by creating new products and services, such as:

- Real estate visualization and management solutions for the construction industry leveraging mixed-reality technologies
- Affordable healthcare solutions for the underserved that leverage inexpensive consumer communication technologies to connect patients with physicians in remote locations

Such activity would increase the size of the overall economic pie and help ensure there are adequate opportunities for all. Increasing the economic pie and distributing opportunities to a wider market with a variety of customer segments would reduce the possibilities of societal backlash to advanced IT adoption.

When used right, technology elevates business productivity and individual performance. It subsumes complexity and enables humans to take on higher-order challenges. When higher-order challenges are not envisioned and pursued, a general perception develops that humans will be left with no jobs as technology takes over the horizons of day-to-day life. That does not raise the bar or set high expectations for ourselves in terms of creating new opportunities and overcoming the challenges of rapid IT diffusion. Yet as history shows in the monumental transitions from an agricultural to an industrial to a service economy, human ingenuity will triumph over this digital tide, yielding new possibilities to creatively engage human potential and productively leverage technology.

Disclaimer: The views expressed in this article are solely those of the author and don't necessarily reflect the views of Microsoft.

ENDNOTES

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Bala Somasundaram is an Enterprise Strategy Advisor with Microsoft Corporation. His current responsibilities include advising CxO clients of Microsoft India on business technology strategy and planning. He can be reached at bsoma@microsoft.com.

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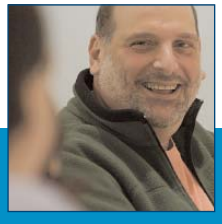



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