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The knowledge society's origins and current trajectory

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ABSTRACT

We address the rise of the knowledge society, reviewing the major contributors to its conceptualization from Karl Marx onward. Synthesizing their ideas, we characterize the current state and direction of the knowledge society, its connection to related ideas of digital economy, e-government, and others, and detail implications for business and other organizations, and for society at large.

1. Introduction

The concerns of corporate executives, policy makers, and students planning careers turn increasingly to the knowledge economy. What does it mean? What are its imperatives for organizations? Is it the far future, the near future, or is it already here?

This paper provides a comprehensive overview of the historical roots and recent debates around the knowledge society and digital economy. Based on a review of some key contributions to the field, it derives the contours of today's knowledge-based activities and their implications for business, not-for-profit enterprises, and society more broadly.

There is as yet no theory of the knowledge society. The paper is motivated not by a gap in theory, then, but by the gap between the pace of technological and social change on the one hand, and the pace of business and policy adaptation on the other hand. Further motivation comes from the varying accuracy of past predictions about the knowledge society, and current disagreements among pundits. We thus trace the development of thought on the knowledge society and the knowledge economy, believing that understanding their historical trajectories can lead to a better apprehension of their future, and hence more effective action.

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Table 1
Old *versus* new.

Old Economy	New Economy
Materialistic consumption.	Dematerialization of daily life (Magee & Devezas, 2017).
Commerce depends on efficiency and security of physical logistics.	Commerce depends on data encryption.
Difficulty of duplicating analog media.	Rights to digital intellectual property.
Land, labor, and capital are the only "factors of production."	Knowledge is a key factor of production (Drucker, 1993).
Physical laborers are replaceable and interchangeable. Hiring halls.	Knowledge workers are not interchangeable. Selecting them is a key challenge for HR departments.
Marketers use product differentiation to justify raising prices.	Customers expect decreasing prices for high-tech goods.
Selling is location-bound.	"Place" matters for some types of commerce; not for other types.
"Bricks": Physical retail store and warehouses.	"Clicks" or "bricks and clicks" (Phillips, Donoho et al., 1997).
Products, services.	Platforms (Phillips, Ochs, and Schrock, 1999).
Hierarchical, command-and-control organizations. "Managers."	Decentralized organizations. Leaders, coordinators, strategists, champions (Drucker, 1993).
Clear boundaries between industries. "Sustainable competitive advantage" strategies.	Dissolving barriers between industries. Companies not sure what industry they are in (Satell, 2015).
Widely accepted accounting conventions for valuing and depreciating physical assets.	Guesswork concerning what data are worth and how long they will retain value.
Cash and checks.	Non-cash, non-paper payment systems.
Owning.	Sharing.
Value grows with the number of customers.	Value grows with the square of the number of customers (Metcalf's Law).

We find roots of the idea of a knowledge society in the 1858 writings of Karl Marx, and we recap key writings from then through the present. From Marx, we move forward in time to Schumpeter (1930s and 1940s); Masuda's 1980 view of the knowledge society in Japan; Drucker's 1993 *Post-Capitalist Society*; Soete (2000); Conceição, Gibson, Heitor, and Sirilli (2001); later researchers addressing global and regional implications of the knowledge revolution; and, finally, recent additions from the trade press. Based on this literature review, we summarize the current status and new directions of the knowledge economy, and draw implications for management and policy.

Pertinent writings refer to knowledge society, digital society, post-capitalist society, digitalization, digital transformation, or industry 4.0. The knowledge society encompasses more than the knowledge economy or the digital economy, including such things as e-government, online education, digital medicine, and online volunteer work, e.g., the SETI project and protein folding.[1] Post-capitalist society, as we shall see when reviewing Peter Drucker's work, means acknowledging that knowledge is a true factor of production in today's world, and that knowledge workers hold the economy's reins as much as or more so than capitalist investors. Industry 4.0 refers to the increased digitalization of manufacturing, especially including robotics. Later in this paper, we draw an "organization chart" of these concepts, showing how our analysis reveals their interrelationships.

Table 1, contrasting the old economy with that which is and is to come, suggests the profound changes that have arisen from the rise of digitalization and knowledge, regardless of what that transition is called. The changes will disrupt markets and society in ways more radical than any "disruptive technologies" (as we usually call them) can do. Progress toward the digital society is marked by punctuations and hiccups, and opposed by powerful entrenched interests, but is inexorable.

As for whether the digital economy is here yet, Table 2 (reproduced from an IBM website) shows that it certainly is. Information and communication technologies, combined with Moore's Law, have produced the networks of alliances that blur industry boundaries.

Tett (2016) cites a McKinsey study claiming "digitization influences up to 98% of the US economy," due to the high penetration of the Internet and smartphones. "The annual growth rate of e-commerce is dependably robust, vacillating between 15 and 17 percent since 2010." Corporations' most popular digital transformation tools as of 2016 are cloud computing and storage, big data analytics, social media, and mobile apps.[2] These statements, powerful though they are, reflect the narrow view of IT service vendors and consultants. They do not reflect the sociological, organizational, and market changes that truly characterize the knowledge society.

We turn now to examining how it got this way. Adam Smith (1720–1790) referred to "new layers of specialists who are men of speculation and who made important contributions to the production of economically useful knowledge" (Parry, 2016). In this early juxtaposition of "knowledge" and "economy," Smith was referring to entrepreneurs and investors knowing where to put their funds. This was a very different usage than that which concerns us at present. Knowledge now resides in workers and consumers.

[1] Home computer users may donate their unused computation cycles to analyze signals from various radio telescopes belonging to the Search for Extra-Terrestrial Intelligence project (setiathome.berkeley.edu). They may do the same—and contribute their own creative input—to cataloguing the three-dimensional shapes of protein molecules (http://fold.it/portal/info/about).

[2] See the infographic at https://sadasystems.com/2016-digital-transformation-survey-Infographic.pdf.

Table 2
"The digital disruption has already happened".

World largest taxi company owns no taxis (Uber).
Largest accommodation provider owns no real estate (Airbnb).
Largest phone companies own no telecommunications infrastructure (Skype, WeChat).
World's most valuable retailer has no inventory (Alibaba).
Most popular media owner creates no content (Facebook).
Fastest growing banks have no actual money (SocietyOne).
World's largest movie house owns no cinemas (Netflix).
Largest software vendors do not write the apps (Apple and Google).

(Source: www.ibmforentrepreneurs.com)

2. Karl Marx (1858)

Although Marx's *Das Kapital* is most commonly remembered for its insistence that the rise of the proletarian laborer would destroy capitalism, Karl Marx (1818–1883) held a parallel, seldom cited theory (Marx, 1858; see also; Fuchs, 2016) to the effect that *knowledge* would "blow [capitalism] sky-high." In his *Grundrisse* (1858), Marx was the first to write that "knowledge has become a direct force of production," an observation that Frederick Taylor would first put into practice 40–50 years later.

> Capital itself is the moving contradiction, [in] that it presses to reduce labour time to a minimum, while it posits labour time … as sole measure and source of wealth …. On the one side, then, it calls to life all the powers of science and of nature, as of social combination and of social intercourse, in order to make the creation of wealth independent (relatively) of the labour time employed on it. On the other side, it wants to use labour time as the measuring rod for the giant social forces thereby created, and to confine them within the limits required to maintain the already created value as value. Forces of production and social relations—two different sides of the development of the social individual—appear to capital as mere means, and are merely means for it to produce on its limited foundation. In fact, however, they are the material conditions to blow this foundation sky-high.

How remarkable that Marx not only anticipated the rise of knowledge as a factor of production, but connected it to "social relations." Today, factory automation, self-driving vehicles, ATMs, etc. minimize the use of labor, for exactly the reasons Marx adduced, and leverage online social networks for advertising and pricing. As Marx foresaw in broad outline, however, ordinary people use "social knowledge" to fight back, via TripAdvisor reviews, online access to restaurant health inspection reports, video recording of police actions, and so on (see Campbell & David, 2016; Milan, 2016).

Marx was not clear on whether he referred to knowledge for creating machines or knowledge for using machines (the latter being Taylor's emphasis). Either way, Marx's was an impressive bit of foresight.

3. Joseph Schumpeter (1943)

Schumpeter, as is well-known, put forward innovation as the driver of the economy. Innovation, of course, requires knowledge. All historical industrial revolutions and Kondratieff waves, however, have been driven by innovation. Schumpeter's work is pertinent to the knowledge revolution first because Schumpeter (1943), like Marx, emphasized sociological forces: "Economic life goes on in a social and natural environment which changes and by its change alters the data of economic action"; and second because Schumpeter anticipated social knowledge not just as a factor of production, but as a driver of change in the means of production.

4. Yoneji Masuda (1980)

Yoneji Masuda (1905–1995) was a pioneer of computerization in Japan. Beginning with Japan's first computer white paper in the mid-1960s, he developed the "Plan for Information Society: A National Goal toward the Year 2000." Following is an extract from one of his best-known books, *The Information Society as Post-Industrial Society,* published in English in 1980 (Masuda, 1980).

> We see that human history has accepted three types of society: hunting, agriculture and industry. It is important to note that the rapid innovation of the social technology system is often the driving force that brings about these social transformations.
>
> The transformation of society is the result of innovation that has focused on productivity. Current social technology innovation does not care about the productivity of material products, but information productivity. At the same time, it is also expected to bring about fundamental changes in human values, ideological trends, social politics and economic structure.

> [In] industrial societies, the dynamism of the invention of the steam engine rapidly increased material productivity, making the mass production of goods and services and the rapid transport of goods possible.
>
> In the information society, an 'information revolution' resulting from development of the computer will rapidly expand information productive power, and make possible the mass production of cognitive, systematised information, technology and knowledge.

This too was extraordinary foresight. Only now have Western economists begun to question their focus on material productivity (Turner, 2016).

Masuda also believed that in the information society, (1) information, the axis of socio-economic development, will be produced by the information utility company, the computer-based public infrastructure; (2) user-generated information will increase and information will accumulate, and cumulative information will be expanded through synergistic production and sharing; and (3) the economy will shift from a structured exchange economy to a synergistic economy.

In the industrial society, Masuda wrote, social activities were enterprises, economic groups—whether in the private sector, the public enterprise, or the third sector of government ownership with private management. In the information society, the most important issue of social activity will be voluntary communities, a socio-economic group that can be broadly divided into local communities and information communities.

Masuda further wrote that the spirit of the information society is also the spirit of the revival of emancipating the human mind, which morally means respect for basic human rights, emphasizing personal dignity and brotherly love to correct the spirit of inequality. The spirit of the information society will be the spirit of globalism, the coexistence of harmony between man and nature, including moral self-discipline and social contribution.

5. Peter Drucker (1993)

As we try to divine the direction of the knowledge economy—and the eventual digital society—we can do no better than to revisit the later work of Schumpeter's protégé, the late business historian Peter Drucker (1909–2005).

In particular, his *Post-Capitalist Society* (1993) inspires and informs the present essay. Although Drucker disingenuously maintained *Post-Capitalist Society* was not a work of foresight,[3] it is instructive to catalog, from today's standpoint which trends he thought important in 1992 did accelerate, and which fizzled. Drucker's brilliance could bring to light the forces underlying socio-economic evolution, but could not always foresee how the forces would play out.

In this section, we will note what Drucker got right, in terms of forecasts, and what he failed to anticipate. Using this information and his further insights, we assess aspects of the state of the digital/knowledge economy/society and its many remaining maturation challenges.

5.1. Drucker's thesis

In *Post Capitalist Society* (1993), Peter Drucker writes that historically, both in West and East, knowledge had always been seen as effete, something pursued by society's upper crust, *quite unconnected to daily work.*

> Then, almost overnight, it came to be applied to doing …. Beginning after 1700—and within an incredibly short fifty years—technology was invented. The very word is a manifesto in that it combines "techn," that is, the mystery of a craft skill, with "logy," [knowledge].

Drucker is implying that craft does not become knowledge until it is made communicable, and is communicated.[4] He credits operations research pioneer Frederick Taylor for being first to systematically apply knowledge to work processes, and communicate his findings. "The application of knowledge to work created developed economies by setting off the productivity explosion of the last hundred years," Drucker writes (1993).

Drucker placed the modern beginning of the knowledge society in the post-World War II years, citing the technological advances of the war years and the determination of the postwar Japanese government to collect knowledge as a resource—making that country the first non-Western nation in modern times to become a "great economic power." Yet as a trigger for the knowledge economy, Drucker (1993) writes,

> My own candidate would be the American G.I. Bill of Rights after World War II, which gave every returning American soldier the money to attend a university—something that would have made absolutely no sense only thirty years earlier, at the end of World War I. The G.I. Bill of Rights—and the enthusiastic response to it on the part of America's

[3] Drucker (1993) wrote that *Post-Capitalist Society* is "a book that is not prediction but description, a book that is not futuristic but a call to action here and now."

[4] David and Foray (2002) agree with Drucker that knowledge is possessed by a community. Grant (1996) disagrees, saying knowledge is "residing within the individual." Grant goes on to say, however, that there is difficulty even in *defining* "knowledge." He defers to the great philosophers on that question.

veterans—signaled the shift to the knowledge society. Future historians may well consider it the most important event of the 20th century. We are clearly still in the middle of this transformation.

Although in Drucker's (1993) words "the last of the mutations that created the Megastate, the Cold War State, was a response to technology," the knowledge economy ultimately weakened the nation-state (see also Phillips & Linstone, 2016). Drucker chastises conservative economists for believing we can go back to strong nation-states, and political scientists and constitutional lawyers for hitching political theory too tightly to the idea of the nation-state.

What replaces the state, Drucker maintained, is the relationship between knowledge workers and organizations. An organization needs knowledge workers to carry out its mission and turn a profit; knowledge workers need organizations as platforms to practice their knowledge. "Developed countries are fast becoming pluralist societies of organizations," Drucker (1993) states, and as a result, non-economic values—"redemption, self-renewal, spiritual growth, goodness, and virtue—are likely to be seen again as existential rather than social goals or political prescriptions".

In traditional work, "the worker is servant to the machine," e.g., the clock or the speed of the assembly line. However, according to Drucker (1993), "In knowledge work and in most service work, the machine (if any) is a servant to the worker." Although many of us feel computers too often tell us what to do, Drucker's distinction is a cogent one: "Knowledge is now fast becoming the sole factor of production, sidelining both capital and labor".

"How knowledge behaves as an economic resource," Drucker (1993) goes on, "we do not yet fully understand." This is as true now as in 1993. At least we do know that "the knowledge-based economy does not behave the way existing theory assumes an economy to behave …. High-tech industry does not follow the supply-demand equations of classical, neoclassical, and Keynesian economics".

Why is all this "post-capitalist"? First, it is because of the new primacy of knowledge as a factor of production, and second because the biggest investors in today's enterprises are pension funds. These are not the traditional independent capitalists who take personal risk with stakes or loans from others; pension fund managers are employees of the fund, having different risk and agency profiles from their capitalist forerunners. Drucker believed the age structure of developed countries implies pension funds will become the "universal ownership mode" in these countries.

"It is no longer even possible to make huge profits by controlling money," Drucker (1993) writes—"The same forces which destroyed Marxism as an ideology and Communism as a social system are … also making Capitalism obsolescent."

5.2. Where Drucker nailed it

In line with what Phillips (2008) called "bounded futures," Drucker noted that "What is unlikely is easier to forecast than what is likely." However, he did make a number of accurate forecasts, as well as astute perceptions of 1993 that remain true today:

- "The developed countries will be inundated by a human flood of Third World immigrants."
- "A … severe problem is the diversion of the scarcest resources—trained engineers and scientists—to economically unproductive defense work. In the United States, 70 percent of all money spent on research and development is spent on defense work."
- "The United States has spent enormous sums of money on technology transfer from defense research to civilian products. The results have been close to zero."
- "GATT (the General Agreement on Tariffs and Trade), while clearly meant to impose transnationalism in … foreign trade, has rarely prevailed against national interests."

5.3. Yet Drucker failed to anticipate

Drucker (1993) wrote that rich people "have become celebrities, [but] economically, they have almost ceased to matter …. And such talk of money as there is, is about the 'excessive salaries' and bonuses of these hired hands [i.e., managers], who themselves own little or nothing." On the contrary, disparities of both income and wealth result from and bedevil today's knowledge economy.

Drucker similarly did not anticipate today's extreme political polarization, runaway "free trade" agreements (Phillips, 2004), the gig economy destroying pensions, the boom in artificial intelligence, or increased government surveillance, all of which do much to shape life today. Nor did Drucker foresee the crash of the Japanese economy, later in the 1990s.

"The institutions of capitalism will survive," Drucker (1993) wrote, "although some, such as banks, may play quite different roles." Much as we might wish for banks to play a better-citizen role, the banks post-crash seem to be back to business as usual.[5]

[5] Not (directly) because they control money, but because of their excessive influence over governments.

Another astute Drucker (1993) distinction, "Technology's impacts are predictable in principle; technology developments are not," is perhaps broadly true, but incremental developments are predictable, and "in principle" is not good enough—as we suddenly realize when a new technology evinces a completely off-the-wall 2nd- or 3rd-order impact.

Finally, Drucker believed that prior to the 1700s, knowledge may have been used in one specific application, but was never developed into general principles that could find application elsewhere. We might add that our ancestors had no understanding that *there could be* general principles. The Celts and ancient Egyptians, for example, were splendid engineers, but there is no evidence that they developed *science.*

6. Luc Soete (2000)

Soete (2000) discussed the cultural and social challenges of digital society. He pointed out that the digital economy cannot be limited to issues of electronic commerce, as ease of communication and access to information and data are essential ingredients of social interaction and democratic expression as well as of economic activities.

Written only four years after the launch of the World Wide Web, Soete's prescient paper argued that:

- Commerce will have to consider the particular features and relative merits of physical *versus* electronic communication and exchange including money exchange. The development of markets in cyberspace thus requires substantial human intervention.
- The three essential conditions for the exchange of material goods—excludability, rivalry, and transparency—do not hold in the exchange of a pure information item.
- Property rights safeguards such as encryption and watermarks will be a central focus of most policy documents on e-commerce. Without these rules creating excludability, Soete wrote, no optimal level of production can be achieved and little indication can be obtained of the sort of products that are wanted by potential buyers.
- Because e-commerce reaches a global customer base, it will increasingly raise issues about competition policy to deal with the "winner takes all" feature of many digital, non-rivalry goods.
- Issues of open standards, compatibility, universal access, inter-connectivity, democratic control, privacy, and new legal and moral issues of collective responsibility will increasingly influence existing competition rules. New questions about data protection and consumer privacy will have to be addressed, with the emergence of new intermediaries competing for access to customer data.
- Continuous upgrading and versioning of goods and services will raise new policy issues, and many other directly policy-relevant issues going beyond traditional economic policy concerns (e.g., the question of who "owns" purchased software).
- The real growth of electronic commerce will not lie in the simple substitution of physical commerce by electronic commerce. Rather, it will lie in what he called "e-exchange," i.e., the opportunities offered by electronic networks for new forms of exchange and communication across businesses, between businesses and consumers, and between consumers to generate value out of such new forms of exchange.
- In the short term, the information highways are likely to significantly reduce costs due to the ease of electronic access and the available databases on products and suppliers. Transaction costs are thus likely to fall and existing intermediary costs decline (This indeed happened; Satell (2015) noted, "So, in effect, the Coasean model has been turned on its head. Technology has minimized transaction costs, while organizational costs have become a heavy burden.").

Soete predicted the growth of Internet-enabled outsourcing, with electronic exchange likely to lead to substantial reorganization of markets with the value chain shifting across business, and the activities that are not part of the core manufacturing or service production of the firm now carried out more efficiently outside of the firm, in specialized companies.

The digital revolution, Soete wrote, will allow not just internal re-engineering processes in the public sector, but also new forms of outsourcing and public-private partnerships. Many areas dominated by public authorities and public service providers such as education, health, culture, media, social services, immigration, police, libraries, and other local services, he added, are typically bound by the geographical limits of the country, province, region, or town within which they operate and are administered. This constrains the growth of their online user bases, compared to the global reach of e-commerce sites.

While the information revolution contributes to increased efficiency in economic production and distribution (and, we add, disposal/recycling), it creates in the first instance increased consumer satisfaction, increased welfare, and freedom of communication and exchange. It is in this sense that the information society takes on its true value, for leisure, household, and other so-called "non-work" activities.

Soete argues that easy access to these new "immaterial" goods and services represents the new wealth of the 21st century. Typically (or, rather, ideally), these are goods and services that in their consumption do not lead to the sort of happiness paradox (first identified in the 1960s by Tibor Scitovsky (1992)) that is characteristic of traditional material consumption.

Seventeen years later, all but one of Soete's predictions have eventuated. Even the one exception—policies attempting to bestow exclusivity on informational goods (the third bulleted item above)—is still practiced, but has become widely scorned, seen as incumbent firms' digging in their heels in resistance to information's tendency to zero marginal cost.

7. Pedro Conceição, David Gibson, Manuel Heitor, and Georgio Sirilli (2001)

Conceição et al. (2001) discussed the emergence of the learning society in tandem with the knowledge economy. They proposed that in a learning society, individuals, firms, and organizations are not merely consumers but actively and continuously seek to nurture, manage, and harvest their knowledge assets.

In this respect, innovation and learning are not limited to immediate technical advances or their applications (including information and communication technologies, ICTs). Changes in the regulatory framework of an industry, shifts in consumers' tastes, demographic makeovers, or even alterations of global geopolitics are considered innovations that affect the development of a learning society. Consequently, the digital economy and the learning society should be viewed through theoretical lenses that accommodate the broader understanding of innovation and learning. The "techno-economic paradigm" (Freeman & Perez, 1986) is one such framework, duly addressing the limitations of the traditional economic viewpoints.

Techno-economic paradigms (TEPs) mainly form by organizing the economic activity around a set of core technologies. When the potential of existing technologies exhaust (or disruptive innovations occur), technical advances and entrepreneurial activities lead to new techno-economic paradigms. A set of core technologies is selected by the market, and the development and diffusion of most products and services hinge on that set of core technologies.

Freeman, Clark, and Soete (1982) identified major techno-economic paradigms: early mechanization in the 1700s, steam engine and railways around the mid-1800s, electrical and heavy engineering from the end of the 1800s to the 1940s, Fordist mass production from the 1930s–1980s, and, finally, ICTs from the 1970s onwards.

The new digital economy and the learning society exist in the current (fifth) techno-economic paradigm, in which innovation and learning practices are largely reliant on electronics, computers, telecommunications networks, and the Internet. An array of opportunities has opened up in all areas of living, business, education, research, healthcare, travel, and farming, and there is no apparent end to its potential.

The current ICT-based TEP brought radical changes to the modern firm, for instance, newer business models, improved ways of working without constraints of time and space, and new media/modes of collaboration. All that is on top of the productivity gains appropriable through process and incremental innovations. The digital product/services/apps innovations in the current ICT-based techno-economic paradigm have brought unprecedented higher returns, hence the new digital economy.

Large variations in the productivity/growth/income of different countries/regions essentially indicate differences in their ability to innovate within the current TEP based on ICTs. In the neo-Schumpeterian tradition, the notions of technological trajectories (Dosi, 1982) and national innovation systems (Freeman, 1982, 1987; Lundvall, 1992; Nelson, 1991) provide an explanation. A national innovation system is typically a snapshot of diverse types of innovation actors in a country, their interactions, and the institutional conditions within which they innovate. Technological trajectories on the other hand depict evolutionary progression of the technological capabilities and assets of an organization or country. Therefore, based on the path-dependencies carved by their unique historical and other contextual conditions, a country (region or firms therein) can only learn (accumulate knowledge) and make progress around specific technological trajectories within the prevalent techno-economic paradigm.

Technology policy plays a large role in shaping the conditions to move up the existing or new technological trajectories, and to foster economic progress within the current TEP.

Because the process efficiency potential of ICTs have been to a large extent exhausted during the early period of the current TEP, there is an increasing need to focus on nurturing a learning society with competencies in economics, management, engineering, and technology. The digital economy has to shift to a learning economy based on innovations by a maximum number of members of the learning society.

Therefore, public policy that leaves everything (or most) to the markets to shape the new digital economy would not be helpful for successful economic progress. In fact, the role of policy should be to actively leverage the potential of ICTs for transformation of information to knowledge and its sharing within and across borders to support learning, knowledge accumulation, and innovation at individual and collective levels. In this regard, education and research agendas supporting the quality of human resources and activities oriented toward the generation and diffusion of knowledge should be top priorities of technology policy.

Successful technology policy for the current TEP should specifically entail:

- Targeting growth of knowledge-based industries.
- Developing social capital well-versed in ICTs, through education and research programs.
- Successfully commercializing scientific R&D outputs in the form of technical and organizational innovations.
- Measuring and monitoring the development of innovation and learning society in an appropriate way.

These authors conclude that to foster a peaceful future, technology policy in the current TEP should also focus on building institutions and supporting conditions for learning and knowledge accumulation at the global level (knowledge society at global level).

Cluster theorists and economic geographers (e.g., Lundvall, 1992; see also; Phillips, 2017) emphasize that regional economic development, and productivity within the firm, are now served by deliberate sharing of knowledge as well as by accidental knowledge spillover and face-to-face transfer of tacit knowledge (Nonaka & Takeuchi, 1995).

8. Robert Ayres and Eric Williams (2004)

Ayres and Williams (2004) valuably recapitulated the information/communication technology (ICT) developments and technology policy developments that underpinned knowledge society early in the new century. They emphasized the "huge amount of misdirected investment" resulting from the untested business models of Internet startups, from the dotcom crash of the late 1990s, from the spate of doomed mergers, and from the Netscape vs. Microsoft browser bundling lawsuit, which broke new legal ground—the law not being prepared for the digital future.

Ayres and Williams (2004) forecast that although the "use of cell phones for communicating text, pictures, and video is a rapidly expanding area, it seems unlikely that these applications will have a macroeconomic impact." They did turn out to have a profound social impact, however, and ultimately economic impact via m-commerce, GPS-driven transportation efficiencies, etc. (Of course, as Ayres and Williams note, these applications depended on cellular networks changing over from analog to digital, which in the U.S. did not happen until the 1990s. The same decade saw the inception of HDTV, digital television.)

Indeed, the Ayres and Williams paper, when departing from ICT technicalities, did address the knowledge society more than the digital economy, focusing on such changes as telework. They were pessimistic about the ability of telework technology to handle group tasks. Today, Google Docs, Google Hangouts, and many other facilities from multiple vendors have solved that problem more or less adequately.

They pointed out that digital society preceded digital economy in a sense, with the U.S. Census Bureau adopting electronic computers in the 1950s—and the military before that—while business adoption did not take off until the late 1950s.

In 2003, "Most business users of computers were, and still are, companies in the service sectors" (Ayres & Williams, 2004). This has changed, as Industry 4.0 places networked robots on the manufacturing floors of America and other countries.

A spot-on forecast by Ayres and Williams was that music would be downloadable as individual songs, rather than as bundled albums, for about a dollar each. Like Soete, they foresaw the privacy issues that plague Internet commerce today.

Ayres and Williams note the convergence of computing and telecommunications technologies that began in the 1960s, and document the simultaneous drops in bandwidth prices and increases in video compression ratios that today have given us streaming Netflix.

Although in pre-World Wide Web and pre-big data times, servers were connected only to LANs (local-area networks) and the demand for servers was limited (Phillips, 1992), by 2003, an incipient "cloud" was driving 50 percent annual increases in server capacity demand (Ayres & Williams, 2004). Likewise, demanded bandwidth per user was doubling every two years (Ayres & Williams, 2004). As our appetite for cat videos seems insatiable, and as the Internet of Things takes off, bandwidth demand seems poised for continued increases—perhaps beyond the capacity of the Internet that now exists.

Progress of the digital society was perhaps slowed, but also perhaps ultimately of higher quality, due to standards wars (HDTV vs. HD-MAC, and CDMA2000 vs. W-CDMA) and a U.S. Federal Communications Commission that "was concerned more with assuring competition than with encouraging innovation" (Ayres & Williams, 2004). Today, especially following the surprise 2016 U.S. presidential election outcome, Internet domain name authority and net neutrality debates present similar challenges.

9. Regional views

9.1. Asia

Guest-editing a special issue of *Technological Forecasting & Social Change*, Sung (2009) noted that the "OECD officially acknowledges the digital economy as a new way of conducting business, and recognizes that digital economy has the potential to radically alter economic activities and the social environment." The digital economy, he says, "allows regional businesses and economies to be less local and more global in keeping with long-term trends toward market liberalization and reduced trade barriers".

Sung's 2009 special issue focused on Asian countries' leveraging of digitization and the knowledge economy in order to overcome the East-West economic gap left over from traditional economies. He summarizes the findings of contributors to the special issue:

- In terms of patents won, South Korea, Taiwan, Singapore, Hong Kong, China, and India have leveraged ICT to become "much larger forces in the world economy".
- In Taiwan's IC design industry, human capital and relational capital, grown through application of ICTs, "improve new product development performance through organizational learning capability".
- IT investment has a positive impact on firm performance in less-developed China, and this impact is similar in direction and size to that experienced by more developed countries, including the United States. (This was an unexpected result.)

- The density of the networks of Korean industries increased over time (from early 1980s to mid-1990s), "implying that the knowledge network has expanded and intensified". However, much remains to be done to advance informatization of non-ICT-related Korean industries.

9.2. Europe

Rodrigues (2002) writes of "a new European strategy which aims to build a knowledge-based economy with more competitiveness and social cohesion." His edited book, with contributions by Lundvall, Soete, and others, also portrays the knowledge revolution as tied to globalization. Challenges include Europe's relations with America, whether the EU model will closely or loosely tie the member countries, gaps between high-skilled and low-skilled European regions, problems of social exclusion, and renewing Europe's social welfare traditions in a more competitive world.

Rodrigues (2002) calls the sacrifice of "social and historical context" for the sake of "modelisation and more precise explanation" a "crucial dilemma," and comes down on the side of including sociological and historical analysis, as did (he notes) Veblen and Schumpeter. As advisor to the prime minister during the Portuguese presidency of the EU, Rodrigues saw this view advanced as a policy. With Europe's knowledge transformation perceived to be lagging America's, a Europe-wide policy push was called for, with the EU's diverse countries serving as living laboratories for policy options, and "open coordination"—a kind of open innovation initiative—used to collate suggestions and best practices.

10. The recent trade press

We now look at recent thinkers who have published outside the scholarly journals.

10.1. Don Tapscott (1995)

In the mid-1990s, consultant Don Tapscott (1995) recognized the emergence of a "digital economy" led by "networked intelligence"—an on-going revolutionary transformation of individual and organizational behaviors (and activities), based on the information available to them plus the potential to communicate and collaborate with each other.

The "networked enterprise," the fundamental unit of the digital economy, relies on applying human know-how to develop and offer new products and services—often disruptive, information-intensive, and somewhat intelligent. Two key enablers of the knowledge work, learning, and disruption in the digital economy are high-speed networks and interactive multimedia led by the convergence of content, computing, and communications technologies (industries).

ICTs support the creation of "networked enterprise" at five different levels, each with its own impacts and implications for the digital economy.

1. Personal multimedia help create a more "effective individual" who is able to carry out personal tasks much more efficiently with high learning competencies.
2. These effective individuals use workgroup computing—leading to major changes in organizational business processes—to become smaller "high-performance teams."
3. Individuals and smaller teams connect and communicate across the enterprise instantly using digital networks and social media. Organizational information travels at light speed across the globe, supporting the emergence of an "integrated enterprise."
4. However, information sharing is not limited to individuals and teams inside an organization. Using inter-enterprise computing technologies, external relationships with suppliers, interest groups, competitors, and customers are redesigned to bolster the overall performance of the entire value network (replacing industry value chains or supply chains). Products and services are increasingly developed and distributed with proactive participation of other actors in the value network. The networked enterprise is an "extended enterprise."
5. Lastly, putting them all together at a higher level, all value-creation activities can be conceived, implemented, and distributed entirely in cyberspace. That means a networked enterprise could also become a fully virtual enterprise, or in other words, "inter-networked business." Such enterprises are the new source of wealth-creation.

Transformation in any sector or industry, Tapscott maintained, could be described by these five levels.

While the businesses aiming digital transformation grapple with technical issues pertaining to digitization, convergence (variety), modularization, intangibility, and velocity of information management, their most critical challenges in transformation from traditional enterprise to the networked enterprise are predominantly management challenges. They involve attracting and retaining a knowledgeable, independent but collaborative workforce, provision of an open communications environment, and development of trust. These challenges are further aggravated by the issues of privacy, information asymmetries, changing work-life balance and social relations, and the impact of easy access to negative online (virtual) experiences.

The key argument put forward by Tapscott is although it is the technology that is revolutionary and disruptive, the core issue of the digital economy remains how the technology largely affects the society, enterprise, and the individual. Wealth and knowledge divides, privacy, and changing social relations and work conditions would need full and conscious attention.

10.2. Bill Gates (1999a, b)

Microsoft founder Bill Gates (1999a, b) also notes that digital technologies and networks have unleashed unique potentials for information work and information flows. While the former is about human thought applied to information at the workplace for problem-solving purposes, the latter implies that information can be instantly exchanged among line workers, managers, suppliers, customers, and other stakeholders.

Gates sees a Digital Nervous System (DNS) at the heart of this exchange, the organizational brain that bolsters thinking and collaboration in the workplace and at the boundaries of the business. He emphasized a DNS is imperative for any business or non-profit that wants to survive in the new economy. A well-functioning DNS allows the firm to answer the harder business challenges, for instance, building innovative new products or an interactive customer service.

A good communications network, an efficient email (messaging/exchange) system, and a web system (providing online forms) are the primary building blocks of an effective DNS. Digital transformation looks easier if it was only about technology. However, corresponding organizational change (learning, adaptation, and capability accumulation) needs much conscientious effort and time, and must be accomplished at a very high speed. It begins with the introduction of simple practices for collecting, processing, and sharing transactional information at various levels (e.g., a paperless office). Ultimately, it involves using such information for strategic decision-making. Real-time data, mobile devices, and wireless connectivity open up new forms of efficiencies in the workplace and on the production floor.

A new web-based lifestyle, flourishing around new forms of content, advertising, and media (Internet/TV/PC combined), has re-defined the business-customer and government-citizen relationships. The size of the organization does not matter anymore in the online economy—experience and service levels do. Therefore, softer aspects of management and the skills/tools for building social relationships are the key differentiators in this increasingly innovative and service-focused landscape. Online information search, online interactions, communities of interests, and communities of practices inside and outside the organization will empower employees as well as affect supplier and customer engagement.

Consequently, a DNS plays an important role in raising the "corporate IQ" of the enterprise in the new economy. It directly improves the most critical antecedents of doing business in the new economy, such as delegation, flexibility, self-service (disintermediation), synergy, and personalization. While physical assets are being transformed into information as much as possible, interactions are also being turned into experiences with the least number of hand-offs. In order to support speed, agility, personal initiative, responsibility, and action-orientation, organizations need to instantly identify and share bad news even more than the good news. Unlike manufacturing industries where information flows for inventory were most important, information for risk is what works for the businesses in emerging sectors of the new economy, according to Gates. Some of the sectors most transformed by DNS, he says, include healthcare, government (public services), and education.

10.3. Paul Mason (2015, 2016)

Mason (2015, 2016) argues that "information is corroding the market's ability to form prices correctly," even as companies fight a rear-guard battle, attempting to "own" information and keep its price high through copyright extensions, nondisclosure and non-compete contracts, and so on. This implies "intellectual property is valued in modern accounting standards by guesswork."[6] We may expect an unstable stock market until this is resolved.

Mason's article, giving no indication that its author has read Drucker, reiterates Drucker's ideas in a gee-whiz-I-just-thought-of-this manner. However, Mason states the ideas' implications in powerful ways, shows that they are much more urgent now than in 1993, and deals with important items that Drucker got wrong (e.g., he notes that "the pension system has been destroyed"). Where Drucker saw the central conflict of the future as between managers and knowledge workers, Mason sees it as between "free and abundant goods and information" and the fragile monopolies that desperately prop up prices.

Mason draws parallels (as did Drucker) between the feudalism-capitalism transition and the capitalism-postcapitalism transformation. Land shortages and the need for military production attenuated the "values" of feudalism, and the new capitalist structure was able to arise with little push-back following the crisis of the Black Plague. Indeed, "[a]t key moments, though tentatively at first, the state switched from hindering the change to promoting it."[7] We now see cracks in the mores underlying capitalism (the mores that sent Max Weber into such raptures); terrorism and climate change might be the crises that fill the role played by the bubonic plague in the mid-1300s.

[6] For a variety of views on accounting valuation in the digital economy, see Bhimani, Alnoor (2003) Management Accounting in the Digital Economy. Published to Oxford Scholarship Online: August 2004. http://www.oxfordscholarship.com/view/10.1093/0199260389.001.0001/acprof-9780199260386.

[7] Mason (2016) believes it will not be state, but rather city officials that will first promote the needed reforms. Unlike Drucker, who believed non-economic values would become personal rather than political, Ida Auken (2016), a member of the Danish parliament (Folketinget), argues that city governments, by embracing the digital sharing economy, can facilitate the emotional satisfaction that comes from the digital alternative to the present growth-obsessed, high-stress, environmentally damaging regime.

Table 3
Milestone dates in the knowledge economy.

1856: Marx's *Grundrisse,* "The Fragment on Machines."
~1910: Frederick Taylor applies knowledge to work processes.
1945: U.S. G.I. Bill (Drucker, 1993).
1970s: Internet.
1980: Japan's Knowledge Society plan.
1990: Senge, "The art and practice of the learning organization."
1995: Nonaka and Takeuchi, *The Knowledge-Creating Company.*
1995: World Wide Web, then (~2000) interactive Web 2.0.
2006–2007: The first iPhone. Facebook opened to general users. Twitter, Hadoop, Kindle, Google Android OS, IBM's Watson AI, Airbnb, GitHub, change.org, the "cloud," and Internet users >1 billion (Friedman, 2016).
2017: Trump attempts to reverse Net Neutrality. Knowledge workers at Google and other tech companies exercise new power, forcing CEOs to disengage from the White House.

11. The foremost thinkers on knowledge society: summary and common threads

11.1. Key dates

Important milestones in the transition to a digital, knowledge-based economy and society have been Karl Marx's long-ignored *Fragment on Machines* (1858), Frederick Taylor's work in the early 20th century, the U.S. G.I. bill in 1944, and the 1970s Japanese work on "knowledge society." Naturally, the Internet (1970s), the World Wide Web (1990s), and especially the more interactive Web 2.0 (early 2000s) were key advances. See Table 3.

Friedman (2016) argues for 2007 as a key date. Late 2006 and 2007, he says, brought us the first iPhone. Facebook opened itself to non-university users. Twitter, Hadoop, Amazon's Kindle, Google's Android OS, IBM's Watson AI, Airbnb, the GitHub open-source software library, change.org, and the "cloud" all took off in 2007—just after Internet users had exceeded a billion in 2006.

11.2. Commonalities and differing views

All the thinkers mentioned in the present historical account[8] saw the knowledge revolution as closely tied to social interactions. Some noted that the economics of the knowledge economy are not yet understood. Their consensus on these points implies there will be no "purely" economic (i.e., centered on price) theory of the knowledge economy; the theory that will eventually emerge will tie economics to sociology, urban planning, and perhaps other disciplines. It will not be a simple theory.[9]

Most of the writers at least implicitly connected the knowledge revolution with a globalized outlook and a more globalized economy. The easy, costless movement of information makes this connection plausible, yet the recent successes of nationalist political candidates in several major countries make it arguable, for now.

Some of the writers saw the knowledge revolution having more impact on public policy, and some focused more on the impact on business firms. Conceição et al., for example, were mainly concerned about the national and policy-level aspects (and issues) of the learning economy. They emphasized knowledge exchange for international shared prosperity. In contrast, Tapscott and Gates both discussed how key technological trajectories unfold for a networked enterprise in a front-runner nation. They did not address the latecomer enterprise (or enterprises from latecomer nations) or variations in their path-dependencies/contexts.

This contrast pointed up the tension between the companies still trying to monetize information, and the public agencies that wish to move information more quickly and cheaply for the benefit of citizens. Even among the latter, there are differences in emphasis, e.g., Conceição et al.'s (2001) emphasis on national and international policies on the one hand, and Mason's (2015) and Auken's (2016) focus on cities as the drivers of the public revolution in leveraging knowledge on the other. It could be noted here that governments have moved more slowly, making the revolution more an evolution, if only because governments must obey their own laws. Tech firms (famously, Uber), in contrast, have openly flouted the laws, in the interest of first-mover advantage.

Some writers view the same aspects of the knowledge revolution from seemingly incompatible angles. Powell and Snellman (2004) see the revolution characterized by the rise of science-based industries, differing rates of innovation in different industries, and the nature of work and its effect on firm performance. This differs from the list offered by David and

[8] We have tried to represent prominent writers spanning the history of the knowledge society idea. The possibility of accidental selection bias remains.

[9] Grant's 1996 paper "Toward a Knowledge-based Theory of the Firm" concedes, "The emerging 'knowledge-based view' is not, as yet a theory of the firm." Perhaps this is because of bounded rationality, as evidenced by the fact that Grant draws heavily on Cyert's and March's behavioral theory of the firm, even as he rightly claims that things are different now.

Foray (2002), which emphasizes the accelerating rate of knowledge creation and obsolescence, growing prominence of intangible capital, the imperative for innovation and change in organizations, and digitalization.

Predictions made by the writers ranged from amazingly prescient to flat-out wrong, and also fell into intermediate positions on that spectrum. Tapscott's ideas of integrated enterprise, inter-networked enterprise, and enterprise architectures, and Gate's conceptualization of Digital Nervous Systems bear strong similarities. Both of them laid down technology-based visions of fast, dynamic, agile, focused, boundary-spanning, collaborative, service-oriented, and knowledge- and innovation-driven enterprises in the digital economy.

However, they did not foresee the exponentially increasing size and complexity of enterprise infrastructure that resulted from the above drivers, for example, the Internet of Things, expected to encompass between 20 and 50 billion devices connected to the Internet by 2020, throwing off torrents of data. Already, more data are now being generated every week than in the last millennia. Consequently, they could not discuss the need for cloud computing, proliferation of online search (to the extent it has become a sector in itself), the huge impact of social media, and the emergence of big data analytics. They also focused on security and privacy from the human and organizational perspective, while neglecting the technical side. Their portrayals of the business future were culture-bound and at most medium-term.

Generally, the many writers' broader, bolder predictions have proven true, with the detailed predictions about the mechanisms of change having a more checkered track record. These facts suggest prediction will remain a risky business for some time to come.

12. Digital economy: status and current directions

In this section, we offer an interpretation of the material presented above, and cautious views of the future.

12.1. Interpretation and synthesis

Knowledge work—activities that involve complex problem identification, problem solution, or high-technology design and that result in innovative new products or services or create new ways of exploiting markets—has become the driver for economic growth and individual and organizational prosperity (Neef, 1998, p. 3).

Therefore, one would expect knowledge- and information-intensive industries such as high tech, financial services, entertainment, health care, education, and government to be those most transformed and benefiting the most from digitization and the Internet. In the medium term, the most visible effects may be seen in retailing, manufacturing, and travel (Carlsson, 2004).

Newspapers, music, finance, and travel agents already have been transformed or obliterated. Facebook, Twitter, smartphones and the "sharing economy" have perhaps surpassed people's expectations, disrupting established structures and economic arrangements. Sectors from accommodation to transport have been disrupted as new applications enable new business services over the Internet. Online video distributors, such as YouTube or Netflix, offer content over broadband networks, beyond traditional cable and broadcasting services. Changes have been equally profound in telecommunication, with voice (VoIP) and text services such as WhatsApp, or KakaoTalk offered over the Internet.

Digital technology is reshaping business models and firms' organization, and making "soft skills," such as information-processing, self-direction, problem-solving, and communication, more important. The effects of digital technologies go beyond employment and skills to the very organization of work, by enabling firms to segment tasks in new ways (Grant, 1996) and to increase the use of temporary labor. Digitization and the Internet, in combination with new software, enable companies to collaborate with suppliers and customers in new ways and thereby to raise productivity.

In the oil industry, higher-resolution (3-D) imaging increased the payoff for accurate drilling. This induced companies to invest in high-tech down-hole sensors. New technology and better oil recovery developed simultaneously, energizing and reinforcing one another. Knowledge, as much as petroleum, is now the critical resource in the oil business. Although the supply of oil is "fixed," the supply of knowledge is boundless (Rauch, 2001, pp. 35–49).

Web technology brings together design engineers in collaborative systems to develop new products. An example is DaimlerChrysler's FastCar project. The company expects to develop the new car 40 percent faster through its new web-based system than in a traditional system in which geographically dispersed engineers communicate via phone, fax, and e-mail and where each proposed design change might require days or weeks. As a result, DaimlerChrysler expects to save billions of dollars on the cost of car development over the next few years (Moozakis, 2000, p. 83). For similar reasons, General Motors can get a car into production in 18 months rather than the 42 months it took in the mid-1990s (Keenan, Ante, Elgin, & Hamm, 2002).

Digitalization plays an important role in the restructuring of economic activities within industries, for example, in the defense industry, where more than 80 suppliers will be working at 187 locations to design and build components of the Joint Strike Fighter. It is up to the 75-member technology group at Lockheed's Aeronautics division to link them all together; Lockheed and its partners will be using a system of 90 web software tools to share designs, track the exchange of documents, and keep an eye on progress against goals (Keenan et al., 2002).

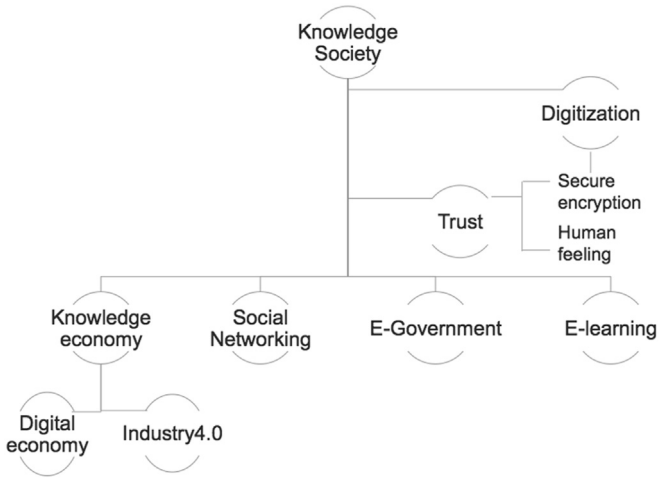

Fig. 1. The knowledge society: A map of concepts.

12.2. Measurement

The Lockheed example conveys the difficulties of measuring the knowledge economy. It is difficult first because there is insufficient theory on which to build measurement scales, and second because the essential factors of human motivation and preparedness are so difficult to measure.

The OECD (2016) and the Digital Economy and Society Index (DESI; https://ec.europa.eu/digital-single-market/en/desi) assess countries' progress toward digitalization, but do not address their cultural contexts, i.e., the surrounding knowledge societies. The World Economic Forum's "Networked Readiness Index" (http://www3.weforum.org/docs/WEF_GITR_Report_2013.pdf) does include cultural, legal, human, and business environment measures. However, it too gives outsize emphasis to computer hardware sales.

The Economist Intelligence Unit's (2010) digital economy survey ranks the world's 70 largest economies on availability and integration of information and communications technology (ICT) for social, cultural, political, and economic progress. Top performing countries show balanced progress on business and legal environments, education, technology policy, and digital services adoption. The report suggests that the digital divide is narrowing among countries. Mobile data tools and educational services are progressing faster in the developing world than in rich nations. Educational levels are improving throughout the world.

The study found that when e-government channels are available, citizens do not necessarily use them. It is a people problem, not a technological problem. On the other hand, the study found that some governments' heavy-handed control of citizens' access to information impedes progress toward a knowledge economy.

The knowledge revolution will change what we must measure, and change the way we measure (Phillips, 2014). Al Shami, Lotfi, Coleman, and Dostál (2015) have put forward interesting ideas in this regard.

12.3. A concept map

Our recapitulation of 160 years of thought makes it clear that *knowledge* takes the dominant role in what is happening today. Digitalization, although hugely important, is just an enabler-facilitator of the knowledge society, and would be neither necessary nor possible in the absence of the knowledge revolution. How humans interact, in social, business, civic, and political organizations, is key. Just as the best power tools will not help an incompetent carpenter, the best digital tools will not empower a dysfunctional organization.

Fig. 1 shows our view of the relationship of the knowledge revolution's main components. The knowledge society encompasses commercial, social, governmental, and educational activities, and all four elements are revolutionized by the new primacy of knowledge as a factor of production. Digitalization supports their respective revolutions, but the revolutions cannot succeed without trust. Digitization (more properly, digitalization) provides one important element of trust, that is, secure communication. The remainder of society's trust comes as always from human attitude and experience. This remainder has not proven scalable beyond workgroups or social groups of a few hundred (Dietz, Ostrom, & Stern, 2003; Dávid-Barrett & Dunbar, 2013), and many current studies address that barrier.

12.4. The future

The transition to a knowledge economy will feel rapid due to the many changes it entails, but it will take a long time for it to be complete. As Drucker (1993) warned, we will live for some decades yet in a dual economy: part capitalist, part post-capitalist.[10]

Like any revolution in production, the knowledge economy will bring positive and negative externalities, job losses being highly visible among the latter. We may expect more M&A activity, with its usual failure rate, some of it motivated by false predictions of economies, some by confusion about industry boundaries, and some by the historical and venal fact that few CEOs get fired during the course of a merger. The digital economy will present challenges for law, accounting, and banking, with all the economically unproductive fees that drive those professions.

The environmental benefits of the digital economy will be significant: Savings in paper (and other materials) and in physical distribution costs may be only the tip of the iceberg, the submarine portion of the berg including reduced pollution from factories, reduced commuting trips due to telework, and "cell phone lots" at airports. Environmental diseconomies include the power consumption and cooling requirements of massive data server arrays, possible health threats from ubiquitous radiation in the Wi-Fi bands, and possible disruption of marine life from laying oceanic fiber optic cables.

The "digital divide" (James, 2002) will persist, with large swaths of the world's population having little access to digital products and services. Income and wealth inequality may worsen as digital goods become the norm in advanced countries.

The richness and nuance of analog life is missing in the digital society. The unexpected and exciting roar of presses and newsboys shouting "Extra!" are with us no more; when Donald Trump won the U.S. presidency in an upset, news organizations did exactly what they would do if a meteorite were about to wipe out all Earthly life—they quietly updated their websites. There will be a backlash against the digital transition, and ultimately, a balance will be struck. More than a century after the industrial revolution, most of the world's people still lived on farms. Now that balance has reversed, urban gardening provides many with a satisfying link to the old regime.

Some people will gravitate toward digital machine-like personal behavior (beat-box singing, robotic dancing, excessive "business process improvement"[11]) even as others go "more human" (Groth, 2016). A better understanding of rationality and emotion in human decision-making may emerge.

Knowledge is power; hence, misinformation becomes a weapon. "Spin," misleading news, and even "fake news" take on new prominence, and not just in public sources: Tiku (2017) documents that Google's intranet news, aimed at employees, deliberately misrepresented a court decision that could affect the company's future. An industry will grow around verification services.

The OECD (1996) recapitulates that this is not just about (price) economics. The OECD report emphasizes power shifts resulting from the knowledge revolution, and the importance of institutions—which, the report notes, do not yet have the tools or expertise needed to govern the knowledge society.

13. Consequences for organizations and society

Companies cannot benefit from the knowledge economy by relying on technology alone. Success will hinge on humans' willingness and ability to assimilate and share information, to make data-based decisions, and to accept new and often inverted patterns of influence within their organizations.

Knowledge workers have inverted the power structure in companies, especially in high tech firms. Google employees' success in demanding that their CEO cease engaging with the newly elected administration in Washington may be startling, but was predictable given the writings of the thinkers cited in this paper—as is the current refusal of technology firm employees to comply with Trump's "Muslim registry" order.[12]

Two *Forbes* columns (Jones & Silberzhan, 2016; McKendrick, 2016) warn against "doing the wrong things even faster," i.e., digitizing legacy business processes without first re-thinking the processes. IT vendors will of course under-emphasize this necessity in order to sell more computer systems faster. Technology is a means of serving customers better, McKendrick reminds us—not an end in itself.

Until a useful socioeconomic theory of the knowledge economy emerges, companies and governments will depend on experimentation and information-sharing as a substitute for theory-based strategy, as Rodrigues (2002) urged for Europe. (Kim, Barua, & Whinston, 2002; Kodama, 2015; Phillips, Lin, and Lin, 2017). We may expect some companies to hedge their bets by establishing a division or skunkworks that embraces the knowledge economy while the traditional divisions act as the reactionary incumbents.

[10] An iconic image of this dual economy is a truck hauling hard drives chock full of data—terabytes that are too numerous to transmit electronically even with today's bandwidth. https://www.wired.com/2016/12/amazons-snowmobile-actually-truck-hauling-huge-hard-drive/?mbid=nl_12216_p3&CNDID=44473061.

[11] "Holacracy was developed by software engineer Brian Robertson, who has sold CEOs like [Zappos's] Hsieh on a product that promises to push humans to run like a computer operating system …. At Zappos, dissatisfaction with holacracy played a role (though it wasn't the only reason) in nearly a third of the company walking out the door in 2015. That same year, Zappos dropped off of Fortune's 'Best Companies to Work for list' for the first time in years" (Groth, 2016).

[12] https://www.usatoday.com/story/tech/news/2016/12/13/tech-workers-vow-not-build-trump-muslim-registry/95407242/.

13.1. Backlash

Companies, especially multinational corporations, now depend on the globalized economy. They will have to manage tensions with political regimes that advocate nationalist economic policies. They should understand that these regimes have arisen as inevitable but temporary reactions against the wrenching changes of the knowledge revolution.

Often going hand in hand with nationalism, the long tradition that Hofstadter (1963) called "anti-intellectualism in American life" is likewise a backlash against the knowledge society. Recent victories of know-nothingism in American electoral politics have caused the *Bulletin of the Atomic Scientists* to editorialize on "the current great danger to a complex, technology dependent society,"[13] and a professor of National Security Affairs at the U.S. Naval War College to warn of "the impending death of expertise."[14]

Consumers are returning to analog products, e.g., music on vinyl disks in lieu of mp3s (Sarpong, Dong, & Appiah, 2016) and books on paper rather than e-books (Nicola, 2017). We see a resurgence of "events" of all kinds, including live concerts. The tourism industry has embraced the "experience economy," and the "maker movement" moves adherents from coding to fabricating physical objects. These mild and agreeable forms of backlash are business opportunities.

Products will combine analog and digital features, e.g., the Sony Digital Paper System[15] and 3-D printers. In the manner of the "analog clock" option on your Macintosh, digital technology will emulate analog readouts when doing so offers cognitive advantages. Consumer research will reveal the best configurations of analog and digital features. High tech will have to remain high touch.

Consumers gain power, vis a vis corporations, via online reviews and "data activism" (Milan, 2016). Instances of customer abuse are filmed on smartphones, and as United Airlines learned in April 2017, upon physically dragging a passenger from a plane, they arouse backlash on Facebook, Twitter, and the blogosphere that in United's case initially cut the company's capitalization by a billion U.S. dollars (Udland, 2017).

13.2. Logistics

Expect continued growth in the packing and shipping industries serving e-commerce. Increased product returns gives rise to "reverse logistics" (Srivastava, 2008). This is especially true in the clothing trade (Venkatesh, 2010). Standards for apparel sizes and for color saturation on computer monitors and phone screens will reduce product returns and reverse-logistics costs.

Forward logistics will transform utterly as 3-D printing decentralizes production.

A glut of used shipping materials gives rise to social initiatives like that described by Leswing (2016), in which Amazon pays shipping for donated items consumers send to Goodwill in used Amazon boxes. Expect other social entrepreneurs to find ways to deal with the environmental diseconomies of the digital society.[16] Peer pressure, peer competition, and gamification seem to encourage charitable and volunteer behavior, such as the cooperative SETI project and the Einstein@home project, in which users donate spare computer cycles to search for gravitational waves in data from the Laser Interferometer Gravitational Wave Observatory, LIGO.[17]

13.3. Industry restructuring

Mergers and acquisitions will be weapons in the battles for control of media content and control of Internet registration and transmission lines. Platform wars will continue.

The unexpected killer app for PCs was the spreadsheet program, and the unexpected killer app for the World Wide Web turned out to be search. Searching "blockchain killer app" reveals (see, in particular, Metz, 2016) the killer app for blockchain technology may not be untraceable money (like Bitcoin). At first, it is likely to be something illegal, like money laundering. Upon maturity (remember, it was not until 2007 that search and social networking overtook pornography as the most-used WWW capability), blockchain's killer app may be cryptocurrency, or insurance, banking, or legal contracts. So it will be with other digital technologies: It will be some time before their biggest markets are identified. This merits careful monitoring.

Fainmesser and Galeotti (2016) introduce the idea of price discrimination based on a customer's network influence. Their thesis seems to depend on information asymmetry (adverse selection), something that is harder and harder for vendors to come by.

[13] http://thebulletin.org/first-july-4-trump-era-declaration10877.

[14] https://www.washingtonpost.com/news/powerpost/paloma/daily-202/2017/07/24/daily-202-trump-marginalizes-experts-debases-expertise/597548fc30fb043679543214/.

[15] https://pro.sony.com/bbsc/ssr/show-digitalpaper/resource.solutions.bbsccms-assets-show-digitalpaper-digitalpaper.shtml?PID=I:digitalpaper:digitalpaper.

[16] Crowdsourcing satellite images to identify potentially valuable archeological sites before they are destroyed by war or development (*Foreign Policy*, The Innovators, December 2016, p. 62). Artist Morehshin Allahyari's 3-D modeling project to preserve for their later reconstruction full images of ancient artifacts destroyed by ISIS (*Foreign Policy*, The Artists, December 2016, p. 67).

[17] *Foreign Policy,* The Chroniclers, December 2016, p. 81.

13.4. Four scenarios for the future of business in the knowledge society

The value drivers for scenario-building seem to be robots displacing human workers, the "digital feudalism" that directs app-generated data and commissions to a small number of platform providers, and what an economic transaction implies about "ownership." Steve Denning comments in *Forbes*,

> Nicholas Colin, Associate Professor in business strategy, Université Paris-Dauphine, envisaged two broad scenarios. One is a downward spiral in which customers will get ever-cheaper products and services, but there will be fewer well-paid employees in their role as customers to purchase them.
> A second scenario, more positive but perhaps less plausible, is that customers and employees might form an alliance in which employees would provide more value to customers, through a rebirth of the union movement, and possibly a stronger role played by social entrepreneurs.

A third possibility is to redefine innovation as an advance that does not attempt to grab rents by owning all information thrown off by a search or a transaction, or by hoarding intellectual property—and encourage innovative activity that adheres to this definition.

Auken (2016) offers another positive scenario based on an extreme sharing economy: "Welcome to 2030. I own nothing, have no privacy, and life has never been better."

Conflicts of interest

The authors declare no conflict of interest.

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