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Alexander Trauth-Goik

University of Wollongong, aptg993@uowmail.edu.au

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Abstract

2020 Taylor & Francis Group, LLC. The Fourth Industrial Revolution (4th IR) is a techno-infused discourse around which high-level discussions of the future have come to revolve. The vision depicted by the 4th IR is one of exponential technological change and convergence, a scene in which disruptive discoveries and their implementation occur simultaneously across the physical, digital and biological spheres. This article examines the development of the 4th IR and assesses the neoliberal logic behind it. Through a discourse analysis of high-level national and intergovernmental strategies, it exposes the business-orientated lean of the 4th IR and draws attention to the inherent focus on the adaptability of business over society in coping with technological change. An ontology of interdependency and an ethics of care is advanced to reimagine technological progress and counter the supremacy of business interest within discussions concerning the future of the human species.

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Abstract

The Fourth Industrial Revolution (4th IR) is a techno-infused discourse around which high-level discussions of the future have come to revolve. The vision depicted by the 4th IR is one of exponential technological change and convergence, a scene in which disruptive discoveries and their implementation occur simultaneously across the physical, digital and biological spheres. This article examines the development of the 4th IR and assesses the neoliberal logic behind it. Through a discourse analysis of high-level national and intergovernmental strategies, it exposes the business-orientated lean of the 4th IR and draws attention to the inherent focus on the adaptability of business over society in coping with technological change. An ontology of interdependency and an ethics of care is advanced to reimagine technological progress and counter the supremacy of business interest within discussions concerning the future of the human species.

Introduction

Recent technological advancement and convergence has spurred the popularization of a future discourse under the name ‘The Fourth Industrial Revolution’ (4th IR). According to the primary individual responsible for the creation and promotion of this concept, Klaus Schwab (2017) of the World Economic Forum (WEF), the 4th IR represents the next stage along the developmental path of humanity, a period characterized by an avalanche spread of new technologies impacting all manner of life phenomena. The 4th IR locates the current era of exponential technological change within a unique socio-historical trajectory and previous waves of industrialization. During the First Industrial Revolution production became mechanized through the use of hydraulic and steam power. The Second used electric power and the assembly of products based on labour division to create mass production. The Third used electronics and information technology to automate

production. Now a ‘Fourth Industrial Revolution’ is deemed to be emerging, characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres. This shift is presented as provoking more upheaval than the previous industrial revolutions because of the speed at which developments take place, the simultaneous nature of radical change across fields, and the transformation of entire systems (Schwab, 2017).

The techno-infused vision of the future propagated by the 4th IR has come to dominate global discussions at both the government and corporate level, as evidenced by the multitude of think tank (Deloitte, WEF, McKinsey and Company), national (Made In China, Japan Revitalization Strategy, Accelerating US Advanced Manufacturing) and intergovernmental (Horizon 2020) strategies that in recent years have made increasing reference to this concept. However, hidden beneath the 4th IR’s promises of increased productivity, economic growth and enhanced options for consumers, lies the veiled assumptions and motivations of those responsible for the creation and propagation of this discourse. This article contributes to the growing body of critical literature examining the 4th IR (see for example Peters, 2017; Pfeiffer, 2017; Avis, 2018; Dean and Spoehr, 2018; Fuchs, 2018; Reischauer, 2018; Hughes and Southern, 2019; Kravchenko and Kyzymenko, 2019). It suggests that as a techno-deterministic continuation of the neoliberal program, the technologies prophesied by the 4th IR are to remain in private capitalist ownership while their ability to address pressing societal challenges remains relegated to an ancillary position. As will be demonstrated through a discourse analysis of national and intergovernmental strategies addressing the 4th IR, meaningful analysis and critique of the unequal social relations determining how the deployment of new technologies will take place remains grossly underrepresented within high-level conversations about the future. The mantle of responsibility for managing the development of new technologies meanwhile finds itself handed to business and industry, those actors who by virtue of their capacity to ‘innovate’ are posited as the most capable of keeping pace with the exponential rate of change depicted. By linking the proclivity for business innovation and competition to a natural process associated with civilizational progress, the discourse seeks to obscure the reality that conceptions of change are value-laden, and that visions of the future vary greatly between different societal actors (Street, 1992). In this way, the socio-technical imaginary of the 4th IR functions to reaffirm the dominant ideological position of neoliberalism and secure its prerogatives into an uncertain and disruptive future landscape. To counter these trends and alter the accelerated pace at which technological change has come to be co-opted under the banner of business and industry, this article underlines the need

for dominant future discourses such as the 4th IR to be opened to a plurality of voices capable of articulating the broad interests of society. It advances an ontology of interdependency that understands human beings as being custodians and caretakers of the natural world and promotes the idea that technological progress be reconceptualised as a means to amplify individual and collective human potential, allowing humans to fulfil these roles.

An Overview of Major Technological Changes

The 4th IR discourse has emerged in response to the accelerated pace at which discovery is being made across a range of fields and the convergence of varied technologies. A snapshot of novel and converging technologies includes the Internet of Things (IoT) (a growing number of physical objects with internet connectivity), artificial intelligence and machine learning (process automation), cyber-physical production systems (smart manufacturing), the co-evolution of big data and algorithmic selection applications (a new form of capital), and genetic engineering (reengineering human and natural biology). Enabling technologies such as these facilitate the creation of 'game-changing products', smart phones, high performance batteries, nanomedicines, smart textiles and 3D printed goods (European Commission, 2013: 9-10). On the one hand they conjure techno-utopic images of smart cities, automated vehicles, localized production systems, sustainable infrastructure and the eradication of disease; on the other, nightmarish visions of ubiquitous surveillance, sci-fi styled military apparatuses, algorithms with political agency and bioengineered inequality. The following is an assessment of the technologies driving cross-sectional and disruptive change.

The Internet of Things (IoT)

The Internet of Things (IoT) describes the exponential growth in the number of physical objects with internet connectivity. By 2025, data networks are expected to be available to every person on Earth at negligible cost (Mauldin, 2018). Meanwhile, uptake of 5G networks across the globe is forecast to dramatically increase the volume and variety of connected device types within society (Deloitte Insights, 2019: 61). In terms of performance, 5G outstrips its predecessor 4G by several orders of magnitude, untethering applications traditionally dependent on cable connectivity such as fibre optic or copper. This technological 'renaissance' is prophesied to envelope the world in highspeed, interconnected and wireless networks (Deloitte Insights, 2019), thereby facilitating the continued breakdown of the 'online-offline'

dichotomy. With a globalised networked system of physical objects seamlessly receiving, generating and sharing information, the virtual and physical realms continue to progress towards full integration. The IoT underpins and feeds into all other technological changes presently occurring. In connecting all shareable physical objects through highspeed internet networks, the availability of underutilized resources may become known and fully utilized by those in need (Shuo-yan, 2018). The IoT heralds the emergence of 'smart cities', serviced by robot rubbish collectors, networks of sensory traffic lights, AI regulated energy usage and air quality controls, and automated transport (Bonasio, 2019; Ellsmoor, 2019). It promises to turn biofeedback data from a variety of wearables devices, ranging from today's smartwatches to tomorrow's augmented- reality goggles, to actionable advice for users in real-time (Deloitte, 2019). However, the proliferation of intelligent interface devices capable of tracking physical behaviour also provides companies with the opportunity to assess the movements of consumers and supply them with an endless stream of targeted advertising (Shuo-Yan, 2018: 115); and governments with the increasing means to control their populations. The IoT therefore speaks to the realization of ubiquitous surveillance regimes of the type envisaged by George Orwell; societies in which government and corporate entities peer into, weigh and judge the lives of all, while the underlying purpose and operation of surveillance remains known to only a select few insiders (Ball et al., 2012: 3; Fuchs, 2018). Indeed, as witnessed in the development of China's Social Credit System, such surveillance regimes underpinned by internet connectivity are already operational in the world today.

Machine Learning (ML) and Artificial Intelligence (AI)

The aggregation of data about individuals, the physical environment as well as context dependant situations feeds into Artificial Intelligence (AI) and Machine Learning (ML) technologies that are transforming the way decisions about all manner of life phenomena are made. AI driven systems are now capable of providing legal services more accurate than a human lawyer, can analyse the content, structure and style of an essay, and mark a variety of exams (Bonasio, 2019). They can evaluate eligibility for loans and mortgages faster than an adept financial adviser, diagnose illnesses more effectively than the expert health practitioner (Liu, 2018: 205) and compose sonatas the envy of renowned musicians (AIVA, 2016). When coupled with the emergence of the IoT, their rapid development raises the possibility of rendering previous ways of performing tasks or making products obsolete (Liu 2018: 197). Already today, AI exert considerable influence over individual and collective lives, either by directly deciding or indirectly manipulating important decisions (Just

and Latzer, 2017; Liu, 2018). This same technology also poses risks to cyber security as hackers co-opt the use of AI to access individual and organizational data. The masses of data available online offer insight into a system's vulnerabilities, threatening the security of key infrastructures increasingly interconnected through the IoT (Fuchs, 2018: 286; Deloitte Insights, 2019: 32).

Cyber-Physical Systems

The compression of space and time characteristic of globalisation and the computing revolution is accelerating through the integration of physical systems with the digital world. Within this evolving scene, the emergence of 'cyber-physical systems' holds great disruptive potential for existing production and management structures (Peters, 2017: 2-3). Cyber-physical systems (CPS) comprise physical production lines linked with autonomous IT operating systems. CPS allow for simultaneous data acquisition and reactive computation, meaning that feedback generated during production is instantly used in real-time computation to control the physical world and proactively solve problems autonomously (Germany Trade & Invest, 2014: 4; Peters, 2017; Shuo-yan, 2018). Real-time knowledge of operational equipment can be used for maintenance purposes prior to a breakdown occurring, reducing the likelihood of interruption in the manufacturing process due to machine failure (Shuo-yan, 2018: 109). Advances in neuroscience and the creation of equipable devices that expand sensory perception could mean that soon a sole human overseer will be capable of gauging the health of entire systems of production contemporaneously (Eagleman, 2015; Schwab, 2017: 60; Pfeiffer, 2017: 110). The speed, scope and global connectivity of cyber-physical systems therefore heralds great disruption to traditional production models and global value-chains.

Big Data and Algorithmic Selection Applications

The co-evolution of big data and algorithmic selection applications embody both a new form of capital and a way for corporations to extract value from individuals in the 21st century. Where on the one hand algorithms serve to personalize experience and streamline individual use of a large range of services, on the other, their advent has radically impacted the commercialization of the internet, a space in which large technology companies now compete with one another over our attention, time and money. Digital businesses now have marginal costs that tend towards zero, meaning that wealth can be created today with much fewer workers (Schwab, 2017: 14). These drastically reduced barriers to scaling have facilitated the rise to global dominance of companies such as Airbnb, Facebook, Amazon, and Netflix, while spurring the rapid

adoption of disruptive technologies and services these companies offer. AI driven algorithmic selection applications employed by these companies filter and sort through big data, providing tailor made experiences to users. In doing so they create personalised media narratives that are entirely distinct from traditional media; with concomitant political consequences. Algorithms are increasingly conceived of as governance mechanisms with a political agency solely their own (Just and Latzer, 2017). Created within the competitive paradigms of leading technology companies, such algorithms encourage the continued atomisation of individual experience, convey and reinforce commercialization as the dominant value, and increase social fragmentation (Just and Latzer, 2017: 251). Shadowing these developments are the rise of 'Deepfakes', AI-based technology that allow for the creation of computer-generated video and imagery of people, places and events that are indistinguishable from the real thing. In response to these developments, a recent bill passed in France now requires the government to publish source code for its algorithms, while the European Commission has championed the call for stronger data protection laws (Bonasio, 2019). The co-evolution of big data and algorithmic selection applications promise to further distort personal and collective understandings of reality and truth, negatively impacting the ability of individuals and groups to reach political consensus.

Genetic Engineering

Elsewhere, advances in molecular biology, genetics, robotics, and nanotechnology paint an image of a future devoid of biological causes of death, or at least envisage one in which people experience reality in a radically different way than how they do today. The thresholds of lifespan, cognition and health are being pushed beyond limitations previously thought to be unsurpassable (Schwab, 2017: 93). Biomedical work on gene therapy conducted in the past decades has largely focused on therapeutic and medical applications addressing diseases and cancers, conditions which arise due to problems concerning the function and growth of cells (Zehr, 2019). Using gene editing techniques such as those popularised by 'CRISPR' technology, protein molecules can be programmed to search for and 'cut' DNA sequences and insert a new sequence to alter the genome. These 'edits' can be passed on intergenerationally, proffering a potential and lasting solution to otherwise incurable diseases and illnesses. However, these advances also entail non-medical applications, such as the bioengineered enhancement of the human form. Recent experiments have demonstrated that human embryos can undergo nontherapeutic gene editing and be brought to term successfully, meaning that enhanced human (or non-human) characteristics in people may soon be a reality (Metzl, 2019; Zehr, 2019).

Meanwhile the burgeoning field of synthetic biology is facilitating the design and construction of new biological components not existent in nature. This new science is revolutionising food and energy production methods through the engineering of unique biological systems. Current applications encompass the development of new plant varieties resilient to changing climates, crops with larger and more nutritious yields, and species capable of sensing and responding to their environment through biosensors and genes that switch on or off in response to certain conditions (Singh, 2014; Knights, 2016; Vickers and Small, 2018). Evidently, the aspirations of biotechnology to manipulate the genetic code, alter certain characteristics of human development, eliminate diseases and gain control over the reproductive process (Street, 1992: 106) are nearing their realization (Metzl, 2019).

A Civilizational Jump?

The tidal wave of technological innovations across the realms of production, human everyday life and physicality has led some to characterize the coming phase in human development as a 'civilization jump' (Kravchenko and Kyzymenko, 2019). A short time ago, the species' growing technological capabilities gave birth to transhuman studies that foresees humans acquiring godlike qualities and remaking the natural world (Campbell & Walker, 2005), posthumanism in which the species merges with technology as the next stage in human evolution (Waters, 2006) and the now popularised idea of a 'Singularity', a point at which exponential change leads humans and machines to become one and where the distinction between real reality and virtual reality breaks down (Kurzweil, 2005). Where these theories do well in identifying the potential for transformational change, they evidently express religious and deterministic overtones (Kostick et al., 2019). The assumption that the currently adopted neoliberal worldview will lead to a techno-utopia belies the reality that inequality, environmental degradation and injustice remain rampant within the current system in which such technologies are constructed. The political frameworks and societal heuristics characteristic of the modern era must first be reconceptualised, and their inadequacies addressed in order for society to progress successfully into a new phase of technological convergence and ubiquity. Yet despite the need for a reconceptualization of politics to match humanities growing techno-sophistication, dominant future discourses endeavour to keep tomorrow chained to neoliberal assumptions of competition, profit and unfettered economic growth.

The Fourth Industrial Revolution Discourse: System Maintenance or Transcendence?

Our perception of reality is informed by language and terminology which enable us to describe abstract concepts and phenomena. A discourse has to be invented that serves to describe the processes which observation or speculation leads one to suppose exist (Street, 1992; Foucault, 1995; Holub, 2001: 169). Discussions concerning the future trajectory of humankind do not occupy a space outside this constructive, and therefore, value-based process. Inherent within the dominant discourse surrounding the techno-future of the species lies the assumptions and ambitions of business leaders, executives and technocrats. In recent years, the conversation surrounding the future has been spurred by the speculations and assumptions of these groups and knit together by a range of national and intergovernmental strategies focused on transformations occurring within and across the sectors highlighted in the preceding section. These processes have culminated in a concept popularised by Klaus Schwab of the World Economic Forum: 'The Fourth Industrial Revolution' (4th IR).

The 4th IR does not simply serve to predict technological change and discuss the associated implications. In doing so, the discourse wills into being the very technologies and systems prophesied. Technological transformation is depicted as a run-away train, with law-makers, regulators and governments forced into an endless game of catch-up. As institutions struggle to keep pace with an avalanche spread of new technologies, levels of dissatisfaction and distrust in mainstream political establishments is building simultaneous momentum (European Commission, 2013: 161; Edelman 2019). The mantle of responsibility for establishing common ethical guidelines meanwhile finds itself placed on the back of business and industry. One of the strongest imperatives articulated within the 4th IR discourse is for companies to innovate. To remain competitive in a world of unchained technological progress, those with the capacity to innovative and keep abreast of exponential change are heralded as society's timely saviours. Governments are expected to step to the side and 'let innovation flourish while minimizing risks' (Schwab, 2017: 69), while the private sector and non-state actors 'take the lead' in regulation and management (Schwab, 2017: 84). It is through the dictate to innovate that business is made responsible for navigating society through the uncertain waters of the future. At a time when the horizon of possibility has been thrust open by a surge in technological convergence, interconnectivity and subsequent discovery, the

4th IR discourse speaks to the latest iteration of the neoliberal program, one veiled in a cloak of technological determinism.

Socio-technical imaginaries such as the 4th IR encode powerful visions of what kind of life is attainable through the pursuit of technoscience. Through their imagining and propagation, such ideas tether the trajectory of future human society to particular values, morals and objectives, thereby co-opting institutionalized understandings of how we ought to coexist (Jepsen, 2017: 112). As aptly observed by Street (1992: 143) "Industrialism is less an economic structure... and more a state of mind." A discourse does not simply encapsulate a shared, common language. Implicit within are the background structures and practices that determine the form and content of this language, the extra-linguistic conditions that determine 'what can be said, and by whom', in the production and distribution of scientific knowledge (Conway, 1996: 138-139). By encasing their narrative within a specialised, technical language and characterizing it as an objective and inevitable historical process, those standing at the vanguard of the 4th IR discourse are capable of dictating the trajectory of technological development. This sentiment is echoed in the work of Reischauer (2018: 26) who characterizes the 4th IR as a "broader communicative action that mobilizes actors to innovate collaboratively and that is driven yet not determined by politics." Avis (2018: 338) similarly understands the 4th IR as an "ideological and rhetorical construction", fundamentally connected to advances in digitalisation, automation, artificial intelligence and the development of smart factories. They argue that the technological developments characteristic of the 4th IR are inseparable from existing social relations and as such remain sites of class struggle. This assertion is confirmed when one considers the identity of those promulgating visions of the 4th IR, typically elite corpuses of technocrats, executives and business leaders. Through the very act of their meeting and discussion, these parties serve to construct a particular understanding of the future and its envisaging (Avis, 2018: 341).

The processes of future narrativization described above are found at the industrial epicentre of thinking in relation to the 4th IR. Heralded by the country's 'Industrie 4.0' strategy, Germany, and more specifically German industry leaders, academics and policy makers, have played an instrumental role in shaping this discourse (Reischauer, 2018: 29). Industrie 4.0 was first introduced at the Hannover Messe Fair in 2011, one of the world's largest trade shows for industrial technology (Rojko, 2017; Pfeiffer, 2017). Since this time the concept has become a common topic of discussion across research, academia and industry, spurring global interest in the evolution of smart factories, the development of the IoT, and the integration of

technical and business processes within companies (Rodrik, 2017: 80). Three German engineers have been identified as the primary inventors of the term, at least one of whom is connected to a high-profile network of industry leaders, politicians, and other influential figures through which Industrie 4.0 has been promoted (Pfeiffer, 2017: 107). Indeed, as noted by Pfeiffer (2017: 108), the first strategic paper published on Industrie 4.0 explicitly described the concept as a ‘vision that has to be shaped’. The value-based observations and speculations about technological change and its effect on business inherent in the discourse has since been replicated across public and private spheres, capturing the imagination of government and industry leaders the world over.

The emphasis on the adaptability of business (over society) to technological change and convergence within this discourse has been further reinforced through the rhetorical and monetary contributions of global financial institutions. The World Economic Forum (WEF) has been cornerstone to the dissemination and development of the narrative surrounding the 4th IR. In 2011 the body founded three projects aimed at consolidating the Industrie 4.0 vision and establishing a platform for dialogue between senior business leaders and policy-makers. The figureheads of these initiatives comprised corporate representatives from companies such as Volkswagen, Bosch, and Daimler, individuals with diverse and high-level political and business relationships (Pfeiffer, 2017: 113). It was during this time period that Chairman of the WEF, Klaus Schwab, formulated his concept of ‘the Fourth Industrial Revolution’ (4th IR) against the backdrop of interviews with global CEOs, senior business executives and representatives from civil society (Schwab, 2017). The introduction of the 4th IR added a historical determinist spin to these conversations about the future. It has strengthened the proclivity for business innovation and competition encouraged in the discourse by linking these ideas to a natural and preordained process associated with civilizational progress. The responsibility for carving a path towards a new tomorrow has subsequently been placed on the back of the above stakeholders. It is important to note that in his original work Schwab openly advocates for direct action on global problems and for conversation about the moral and ethical implications of the forecast wave of technological change to be opened up to a plurality of voices. As he explains in relation to the development of the 4th IR “a future that works for all by putting people first, empowering them and constantly reminding ourselves that all of these new technologies are first and foremost tools made by people for people” (Schwab, 2017: 105). Grandiose and egalitarian remarks such as these are replete throughout Schwab’s book, yet their polemic nature serves to distract from the undercurrent

running through the 4th IR discourse; that it be under the banner of business and industry that these actors are to gather.

Aside from the important rhetorical and ideational role played by the WEF in relation to the development of the 4th IR discourse, the body has also contributed significant material and monetary resources. The above dynamic is visible within the recently founded ‘Centre for the Fourth Industrial Revolution Network’, which in 2018 launched new hubs in China, India and Japan. The Network is focused on the promotion of global technology governance and the cross-industry impact of new technologies. One of the primary functions of the Network is to co-design, test and refine governance protocols and policy frameworks addressing advanced technology to ‘accelerate impact and drive change’ (WEFa, 2019: 8). At the 2019 WEF annual meeting in held in Davos Switzerland, the concept of ‘Globalization 4.0’ was introduced and heralded as the next, more deeply integrated phase of globalization. Globalization 4.0 comprises a new framework of rules and institutions which would primarily serve to deepen the integration of global economic cooperation in the context of the 4th IR (WEFb, 2019). Such events and initiatives evidently portray the 4th IR and its business orientated temperament as an inevitable outcome of progress, failing to question whether the accelerated pace at which we hurtle towards this techno-future is even desirable (Johns, 2019). This iterative and circular process of knowledge creation ensures that the dominant vision of the future, its heralded shape and characteristics, remains tethered to the logic of markets, competition and economic exigences. In other words, the rapid pace of transition towards the new technological frontier of the 4th IR is not the result of purely objective transformative processes in science and society (Kravchenko and Kyzymenko, 2019). On the contrary, it is the governments of economically developed countries and transnational corporations that are endeavouring to create the socio-cultural preconditions necessary for a civilizational leap, one which is tailored in their image (Pfeiffer, 2017).

A Discourse Analysis of National and Intergovernmental Strategies

We encounter a number of recurring themes within strategies addressing the 4th IR which testify to the circular and reciprocal nature of this discourse. A large list of countries and intergovernmental bodies have established strategies in response to the growing popularity of both the 4th IR and Industrie 4.0. Such strategies geared towards dealing with technological change and convergence differ in terms of name

and scope but not in fundamental logic. The USA emphasises the transformation of manufacturing (Advanced Manufacturing 2.0), Germany automation and data exchange (Industrie 4.0), Japan, AI and robotics (Japan Revitalization Strategy), China, dominance in an array of high-tech industries (Made in China 2025). These initiatives and the strategies contained within them focus primarily on such things as market competitiveness, innovation and new business models, digital start-ups and ecosystems, promotion of coordinated research, sustainability and image (Lee et al. 2018: 7; European Commission, 2013). What they all share in common however, is the narrow lens of innovation and competitiveness through which the prospect of technological convergence is appraised, thereby revealing the underlying assumptions and motives of leading classes located within the existing market economy. In his original work, Schwab (2017) identifies the societal challenges presented by the 4th IR and acknowledges the risks posed to the global middle class, the environment, inequality and the nature of work. However, as table 2.0 demonstrates, such concerns have not materialised as major priorities within national strategies. On the contrary, the 4th IR is presented as an opportunity to upgrade existing business ideologies and structures, rather than as an opportunity to address the inequalities these structures propagate. As will be argued in the proceeding section, during a time of unprecedented technological advancement and convergence, the focus is on system *maintenance* rather than *transcendence*.

National and intergovernmental strategies chosen for this study were selected on the following basis. That (1) they were published within a five year time span from the introduction of Industrie 4.0 at Hannover Fair in 2011, (2) they articulated a vision of their future societies in reference to the technologies cited in the previous section (3) they cited Industrie 4.0 or the Fourth Industrial Revolution and (4) that they were published by official government ministries, committees or advisory bodies.

National & Intergovernmental Strategies	Keywords & Times Cited (Economics & Business)					
	Industry/ Industries	Business/ Businesses	Job(s)/ Career(s)/ Employment	Profit(s)/ Profitability/ Growth	Competition/ Competitiveness	Innovation/ Innovative
Industrie 4.0 (Germany)	63	38	4	19	17	37
Japan Revitalization Strategy	87	130	114	72	59	45

Horizon 2020 (EU)	78	64	59	51	112	487
Advanced Manufacturing: Beyond the Production Line (Australia)	75	99	56	62	86	137
Made in China 2025	33	14	0	4	26	80
Accelerating U.S. Advanced Manufacturing	102	41	102	15	38	95
TOTALS	438	386	335	223	338	881

Table 1.0 Strategies Targeting the Fourth Industrial Revolution and Predominate Business/Economic Related Keywords
(Excludes job and policy titles, biographies, business names, endnotes and references)

‘Innovation/innovative’ was the most prominent keyword cluster across all strategies addressing technological change, featuring as the top keyword cluster within Horizon 2020 (EU), Advanced Manufacturing (Australia) and Made in China 2025. The ‘Industry/industries’ cluster came in second place, most cited in Industrie 4.0 (Germany), and tied first with ‘jobs/careers/employment’ in Accelerating U.S. Advanced Manufacturing. The ‘Business/businesses’ keyword cluster was the third most prominent across strategies and the most common within the Japan Revitalization Strategy. The overarching reference to ‘innovation’ across all strategies confirms Reischauer’s (2018) characterization of the 4th IR as a broader communicative action that mobilizes different actors to innovate. The secondary prominence of ‘business’ and ‘industry’ keyword clusters indicate that these sectors are expected to drive innovation forward, playing a more significant role in managing the trajectory of society versus government or civil society. Low numbers of the ‘job(s)/career(s)/employment’ cluster across all strategies may indicate a shifting consensus that jobs and employment will not contribute to future growth and innovation during the next phase of the Information Age. High levels of this keyword cluster featured in Advanced Manufacturing (Australia) due to a discussion concerning the trend of falling employment rates in manufacturing. The publisher, the Committee for Economic Development of Australia (CEDA) itself conceded that the changes to the industry may have "severe implications for employment levels and the tax base, with associated social and economic challenges" (CEDA,

2014: 49). Despite this acknowledgement, as indicated by the findings in table 2.0, the CEDA did not link these issues to the notable social consequences of poverty and worsening inequality. A similar focus on jobs was visible within the counterpart strategy released by US authorities which highlighted the need to rejuvenate faith in the American manufacturing sector after 6 million jobs were lost during the decade leading to the Great recession of 2008-2009 (President's Council of Advisors on Science and Technology, 2014: 88). Overall, the contrast between the 'job(s)/career(s)/employment' cluster and the highly cited 'Industry/industries' and 'Innovation/innovative' clusters is indicative of the growing imbalance between capital and labour in the context of the 4th IR.

Interestingly, the reverse of this trend was witnessed in the Japan Revitalization Strategy which had high numbers of the 'job(s)/career(s)/employment' keyword cluster. In comparison to other strategies on the list, the Japan Revitalization Strategy exhibited a far greater focus on both job retention and employment growth into the future. This thread of concern has found itself reiterated in consecutive Japanese strategies, including that of 'Society 5.0', a concept introduced by the Abe administration in April 2016. Society 5.0 promotes a vision of an ideal techno-society informed by 'a new social consensus', undercut by the need for individuals to 'relearn skills in accordance with their individual abilities and expertise' (Japanese Council for Science Technology and Innovation, 2016: 5; Granrath, 2017). Society 5.0 presents the most human-centred strategy aimed at charting the shifting landscape of the future, exhibiting the Japanese government's attempt at balancing the needs of citizens versus capital. The effort towards 'the realization of a human-centred society' is one which the document demonstrably advocates for, while dually acknowledging that future technological changes will impact every aspect of society, not only industrial production (Granrath, 2017). And yet, as has been the case with other strategies, the necessary steps aimed at achieving such a paradigm shift towards a human-centred society are critically lacking. Ultimately, Japan's vision of Society 5.0 remains tethered to an overarching concern for the country's continued competitiveness within the global market of today, thereby restricting its ability to offer an alternative discourse to that being propagated by the 4th IR.

The proceeding section further testifies to the focus on the adaptability and leadership of business within context of the 4th IR by providing an analysis of keywords associated with pressing societal challenges. Social and political keyword clusters were developed in line with the goals of the 2030 UN Agenda for Sustainable Development. In particular, goals 1 (eradication of poverty), 3 (healthy lives for all

at all ages), 4 (quality education and lifelong learning), 8 (productive employment and decent work), 10 (reducing inequality within and among countries), 13 (urgent action to combat climate change) and 16 (access to justice and inclusive institutions) (UN General Assembly, 2015).

As demonstrated by the findings listed in table 2.0, none of the societal challenges raised above took precedence over those business orientated keywords cited in table 1.0. Across strategies, the strongest emphasis was on the ability for 4th IR technologies to contribute towards solving environmental pollution/climate change and for society to facilitate long-term education/lifelong learning opportunities. Importantly, the data indicates that some countries were more inclined to include consideration for societal challenges within the discourse than others. The issue of poverty and inequality, perhaps two of the biggest challenges implicated by realization of the 4th IR, were not represented within any national strategy, the exception being their appearance within the EU's Horizon 2020. Unlike other strategies focused on market and economic concerns, Horizon 2020 made significant reference to both poverty and inequality among the other societal challenges listed. This may be contributed to the documents three mutually reinforcing priorities of a) excellent science, (b) industrial leadership and (c) societal challenges (European Commission, 2013: 110). The high number of cited keywords relating to environmental pollution, sustainability and climate change, demonstrates the EU's commitment to tackling this issue. As explained within the strategy, "Dealing with climate change is a cross-cutting priority in Horizon 2020 and accounts for 35% of the overall budget across the programme" (European Commission, 2013). The Japan Revitalization Strategy expressed a clear concern for issues of social exclusion/inclusion and lifelong learning. However, both social participation and education related keywords were found to be predominately cited in reference to the promotion of expanded work opportunities for women, the young and elderly given the country's ageing society. Ultimately, the stark contrast between business/industry versus social/political orientated keywords raised through this discourse analysis underlines the dominant interests of business over that of society within the context of the 4th IR.

National & Intergovernmental Strategies	Keywords & Times Cited (Social & Political)				
	Climate Change/ Environment(al)/ Pollution/ Sustainability	Poverty/ Inequality(ies)	Ageing/ Aging Demographic Change(s)/shift(s)	Social Exclusion/ Participation	Education/ Learning/ Lifelong Learning
Industrie 4.0 (Germany)	2	0	3	0	3
Japan Revitalization Strategy	1	0	9	37	39
Horizon 2020 (EU)	79	18	20	3	41
Advanced Manufacturing (Australia)	2	0	2	0	15
Made in China 2025	17	0	0	0	9
Accelerating U.S. Advanced Manufacturing	0	0	1	0	33
TOTALS	101	18	35	40	140

Table 2.0: Strategies Targeting the Fourth Industrial Revolution and Social/Political Related Keywords (Excludes job and policy titles, biographies, business names, endnotes and references)

A New Conception of Technological Progress: An Ontology of Interdependency and an Ethics of Care

The discourse analysis of major strategies presented in the preceding section draws attention to the exclusionary nature of the 4th IR and clearly highlights the one-dimensional and business orientated view of the future advocated for by proponents of this particular narrative. Ultimately, business and industry are depicted as the primary actors responsible for safeguarding the interests of humanity as the species progresses towards increasing technological enmeshment. As evidenced by table 2.0, the imperative for profits and competition inherent within the 4th IR discourse

continue to be elevated above the environment and the common good of the people. The 4th IR encapsulates a worldview predicated on neoliberal economics, one in which business exists separately from, and is able to effectively command, other social actors. In endeavouring to keep separate the interests of business and wider society, the techno-orientated ontology presented by the 4th IR discourse invites innovation and creativity which is demonstrably misaligned with the long-term interests of the species and planet (Martorana & Smith, 2018). To combat the dominance of this discourse and reclaim the promises presented by a future yet realised, discussions and strategies concerning technological progress must come to emphasise an ontology of interdependency and an ethics of care.

The logic presented within the 4th IR discourse reflects a Cartesian-Newtonian worldview predicated upon the separation of the individual (business) from the collective (society) and the subjective (human actors) from the objective (technology). Business is portrayed as the sole actor capable of safeguarding the interests of the planet and species as technological progress accelerates and technologies of a seemingly preordained nature proliferate. To challenge this epistemology and the techno-deterministic framing of technology inherent within the 4th IR discourse, the etymological roots of the word 'technology' must be re-established. Derived from the Greek words *techne* 'art, skill, cunning of hand' and *logia* which denotes the study of something, the cultural underpinning of the word 'technology' speaks to close human engagement in a world that people are crafting, transforming and gaining knowledge about (Hill, 1988). For the Greeks this was a world defined, not by humanity's mastery over nature, but the species protective and reciprocal role within it. The etymology of the word technology therefore speaks to a worldview of interdependency and holism, an ontology that must be re-established within discussions about technological progress.

In his novel *The tragedy of technology*, Stephen Hill (1988) claimed that human purpose had gradually become subsumed by the external systematic ordering of human affairs underpinned by industrialised technologies. Since humankind became wedded to the modern scientific endeavour, a hybrid project underpinned by a positivist epistemology bound to the ontology of Descartes, previously undreamt-of discoveries and life-altering inventions have undoubtedly been produced. The Enlightenment signalled a break from previously held superstitions of the mind and the worship of idols, a new conception of progress informed by the positivist-cartesian paradigm adopted by the natural sciences and spurred by capitalist industry (Jameson, 2008; Biel, 2016). Science promised to sever the chains binding humanity to gods whose logic remained impenetrable to the human mind, but under whose

care ultimate trust had come to be placed. The transition from providence to progress thus embodied the transition from superstition and blind faith, to logic, rationality and science. A defining moment in which control over the destiny of the species was wrested from the paternalistic patronage of faith-based religion and delivered into the collective hands of thinking, feeling human beings. As evidenced by the 4th IR discourse, the philosophical tradition of positivism continues to ground mainstream methods of both inquiry and progress, insisting that value-free judgements can be made about an independent reality and that our understanding of facts can be separated from our relationship with them (Bleiker, 2011; Reuten 2019). In light of present conditions and trajectories however, it appears the path trodden may in fact be that of a full circle. As the 4th IR discourse demonstrates, the belief humanity has placed in the scientific paradigm which first delivered it from the clutches of supremely powerful, unknowable deities is now being entrusted to the imperatives of neoliberal business.

The technologies heralded by the 4th IR need to be reframed as a means for human beings to reconsider the nature of their relationships and the planet. Inventions borne from science and technology both expand existing capacities for action and create entirely new paths for change in the process (Srnicek and Williams, 2015: 82). Future narratives discussing the implications of technology on society and the natural world must begin to emphasise the interdependent nature of reality which underlie recent discoveries within the sciences upon which 4th IR technologies are predicated. Different scientific disciplines including, quantum physics, cosmology and psychology are all arriving at the same consensus; that reality and consciousness are interdependent and inextricable from one another (Capra, 1975; Bányai, 2019). In physics, revelations from the subatomic world have forced scientists to acknowledge the inadequacy of precise measurement and prediction and accommodate a new worldview where mind and matter, fact and value, cannot be divorced (diZerega, 1991; Munro, 1991; Müller-Kirsten, 2006; Bányai, 2019). The position of a subatomic particle cannot be confidently deduced using traditional methods of measurement. The identity of a subatomic particle at any point in time is characterised by probability, meaning that there can only be a tendency for the particle to exist in various places (Capra, 1975: 138). In other words, an impenetrable cloud of possibility surrounds the location of an atom in space-time. The relational worldview animating the discovery of wave-particle duality and the centrality of perspective within this view stands in contention with the neoliberal and techno-deterministic worldview of the 4th IR discourse. As technologies enabled by quantum physics and heralded by the 4th IR grow in prominence, it ought to at least be

considered how the interdependent view of reality espoused by quantum theory can be applied within the articulation of future narratives.

Subscription to an ontology of individualism, separation and reductionism fail to reflect the dynamism, interpenetration and ultimate holism of the universe human beings inhabit. In striving to safeguard, protect and improve the long-term interests of the planet and species, discussions concerning the development and application of technologies must ground themselves upon an ontology of interdependency which can draw inspiration from the etymological roots of the word 'technology'. A view of human beings existing as custodians and caretakers in close connection with the natural world, not divorced from nature and rendered slaves of technologies designed in the image of capitalist enterprises. The overarching concern for competitiveness and the primacy of industry and business written into the design and application of new technologies must shift to encompass the perspectives of stakeholders who are capable of articulating the broad interests of society. Such a paradigm shift in our perception of the technological future of the species can draw further inspiration from two of Bányai's (2019) four fundamental ontological precepts underlying the conception of an 'Eternal Order'. First, that matter (technology) depends and is borne from consciousness (human beings). Second that the success and flourishing of the individual (business/industry) depends on the comprising broader collective (society/planet). Instead of taking the technologies of the 4th IR as a given and overlooking their ownership within the hands of industry and business, we should appraise these tools as potential mechanisms of civilizational transformation and strive for common ownership (Fuchs, 2014; Srnicek & Williams, 2015; Fernández-Herrería, 2019). Disputing the neoliberal worldview and redirecting technological progress towards long term, progressive ends necessitates that we advance an ontology of interdependency and holism (Bányai, 2019) paired with an ethics of care (Fernández-Herrería, 2019). A future narrative capable of challenging the 4th IR discourse would take inspiration from the etymological roots of the word 'technology' and the conception of close human engagement with the natural world. It would revolve around an understanding of human-beings existing as the caretakers and custodians of life (Fernández-Herrería, 2019) rather than resign humanity's future to the aspirations of competing capitalist enterprises. In this depiction, the technologies humans create assist in realising individual and collective human potential while maintaining harmony for life on Earth. Ultimately, future discourses must acknowledge that the benefits and impacts of technological change have unbalanced effects, shifting from a fundamental focus

on the adaptability of business, to a concern for the overarching prosperity of the planet, society and its members.

Bibliography

- Aiva. (2016). *AIVA - "Genesis" Symphonic Fantasy in A minor, Op. 21*. Retrieved June 26, 2019, from <https://www.youtube.com/watch?v=Ebnd03x137A>
- Avis, J. (2018). Socio-technical imaginary of the fourth industrial revolution and its implications for vocational education and training: A literature review. *Journal of Vocational Education & Training*, 1–27. <https://doi.org/10.1080/13636820.2018.1498907>
- Bányai, O. (2019). The Foundation of An Upcoming Civilization Able To Reach Its Fulfillment Within The Ecological Limits of The Earth: The Eternal Order. *World Futures*, 75(5–6), 298–323. <https://doi.org/10.1080/02604027.2019.1591812>
- Ball, K., Lyon, D., & Haggerty, K. (Eds.). (2012). Introduction: Understanding Surveillance. In *Routledge Handbook of Surveillance Studies*. Routledge. <https://doi.org/10.4324/9780203814949>
- Biel, R. (2016). Dialectics of a (re)discovered sustainability. In *Sustainable Food Systems: The Role of the City*. UCL Press. <https://doi.org/10.2307/j.ctt1j1vzc5>
- Bonasio, A. (2019, February 4). Report: 2019 Tech Breakthroughs. *Tech Trends*. <https://techtrends.tech/tech-trends/report-2019-tech-breakthroughs/>
- Bleiker, R. (2011). Postmodernism. In R. Devetak, A. Burke, & J. George (Eds.), *An Introduction to International Relations* (2nd ed., pp. 91–102). Cambridge University Press. <https://doi.org/10.1017/CBO9781139196598.009>
- Campbell, H., & Walker, M. (2005). Religion and Transhumanism: Introducing a Conversation. *Journal of Evolution and Technology*, 14.
- Capra, F. (1975). *The Tao of physics: An exploration of the parallels between modern physics and eastern mysticism*. Wildwood House.
- CEDA (the Committee for Economic Development of Australia). (2014). *Advanced manufacturing: Beyond the production line*. <https://www.ceda.com.au/CEDA/media/ResearchCatalogueDocuments/PDFs/22092-Advanced-Manufacturing.pdf>
- Chinese State Council (Ed.). (2015). *Made in China 2025 (中国制造 2025)*. <http://www.cittadellascienza.it/cina/wp-content/uploads/2017/02/IoT-ONE-Made-in-China-2025.pdf>
- Conway, D. W. (1996). *Nietzsche and the political*. Routledge.
- Dean, M., & Spoehr, J. (2018). The fourth industrial revolution and the future of manufacturing work in Australia: Challenges and opportunities. *Labour & Industry: A Journal of the Social and Economic Relations of Work*, 28(3), 166–181. <https://doi.org/10.1080/10301763.2018.1502644>
- Deloitte Insights. (2019). *Tech Trends 2019: Beyond the digital frontier*. Deloitte. <https://www2.deloitte.com/insights/us/en/focus/tech-trends.html>

- diZerega, G. (1991). Integrating Quantum Theory with Post-Modern Political Thought and Action: The Priority of Relationships over Objects. In T. Becker (Ed.), *Quantum politics: Applying quantum theory to political phenomena*. Praeger.
- Eagleman, D. (2015, March 18). *Can we create new senses for humans?* | David Eagleman—YouTube. <https://www.youtube.com/watch?v=4c1lqFXHvqI>
- Edelman. (2019). *2019 Edelman Trust Barometer* | Edelman. Edelman. <https://www.edelman.com/trust-barometer>
- Ellsmoor, J. (2019, May 19). *Smart Cities: The Future Of Urban Development*. Forbes. <https://www.forbes.com/sites/jamesellsmoor/2019/05/19/smart-cities-the-future-of-urban-development/>
- Europäische Kommission (Ed.). (2013). Establishing Horizon 2020—The Framework Programme for Research and Innovation (2014-2020). *Official Journal of the European Union*, 1291, 104–173.
- Fernández-Herrera, A., & Martínez-Rodríguez, F. M. (2019). THE Earth Charter as a New Worldview in a Post-Neoliberal World: Chaos Theory and Morphic Fields as Explanatory Contexts. *World Futures*, 75(8), 591–608. <https://doi.org/10.1080/02604027.2019.1634417>
- Foucault, M. (1995). *Discipline and punish: The birth of the prison* (2nd Vintage Books ed). Vintage Books.
- Fuchs, C. (2014). *Digital labour and Karl Marx*. Routledge, Taylor & Francis Group.
- Fuchs, C. (2018). Industry 4.0: The Digital German Ideology. *TripleC: Communication, Capitalism & Critique. Open Access Journal for a Global Sustainable Information Society*, 16(1), 280–289. <https://doi.org/10.31269/triplec.v16i1.1010>
- Germany Trade & Invest. (2014). *Industrie 4.0: Smart Manufacturing for the Future*. Germany Trade & Invest. http://www.inovasyon.org/pdf/gtai.industrie4.0_smart.manufact.for.future.july.2014.pdf
- Granrath, D. L. (2017, August 29). Japan's Society 5.0: Going Beyond Industry 4.0. *Japan Industry News*. <https://www.japanindustrynews.com/2017/08/japans-society-5-0-going-beyond-industry-4-0/>
- Hill, S. (1988). *The tragedy of technology: Human liberation versus domination in the late twentieth century*. Pluto Press.
- Holub, R. (2001). *Antonio Gramsci: Beyond Marxism and postmodernism* (Transferred to digital reprint). Routledge.
- Hughes, C., & Southern, A. (2019). The world of work and the crisis of capitalism: Marx and the Fourth Industrial Revolution. *Journal of Classical Sociology*, 19(1), 59–71. <https://doi.org/10.1177/1468795X18810577>
- International Labour Organisation, & Global Commission on the Future of Work. (2019). *Work for a brighter future*. https://www.ilo.org/global/publications/books/WCMS_662410/lang-en/index.htm
- Jameson, F. (2008). Persistencies of the Dialectic. In B. Ollman & T. Smith (Eds.), *Dialectics for the new century*. Palgrave Macmillan.
- Japanese Council for Science Technology and Innovation. (2016). *Comprehensive Strategy on Science, Technology and Innovation 2016*. Japanese Cabinet Office. <https://www8.cao.go.jp/cstp/english/index.html>

- Jepsen, K. S. (2017). Imaginaries of Modernity: STS and Topographies of Power. *Science as Culture*, 26(1), 111–116. <https://doi.org/10.1080/09505431.2016.1238887>
- Johns, J. (2019, January 23). *Davos: Leaders talk about globalisation as though it's inevitable – when it isn't*. The Conversation. <http://theconversation.com/davos-leaders-talk-about-globalisation-as-though-its-inevitable-when-it-isnt-110216>
- Just, N., & Latzer, M. (2017). Governance by algorithms: Reality construction by algorithmic selection on the Internet. *Media, Culture & Society*, 39(2), 238–258. <https://doi.org/10.1177/0163443716643157>
- Knights, S. (2016). *Transformative Technology Fact Sheet – Synthetic biology* (16/035). Rural Industries Research & Development Corporation. <https://www.agrifutures.com.au/wp-content/uploads/publications/16-035.pdf>
- Kostick, K., Fowler, L., & Scott, C. (2019). Engineering Eden: Does Earthly Pursuit of Eternal Life Threaten the Future of Religion? *Theology and Science*, 17(2), 209–222. <https://doi.org/10.1080/14746700.2019.1596289>
- Kravchenko, A., & Kyzymenko, I. (2019). The Fourth Industrial Revolution: New Paradigm of Society Development or Posthumanist Manifesto. *Philosophy & Cosmology*, 22, 120–128.
- Kurzweil, R. (2005). *The singularity is near: When humans transcend biology*. Viking. http://ebook.3m.com/library/BCPL-document_id-d574z9
- Lee, M., Yun, J., Pyka, A., Won, D., Kodama, F., Schiuma, G., Park, H., Jeon, J., Park, K., Jung, K., Yan, M.-R., Lee, S., & Zhao, X. (2018). How to Respond to the Fourth Industrial Revolution, or the Second Information Technology Revolution? Dynamic New Combinations between Technology, Market, and Society through Open Innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 4(3), 21. <https://doi.org/10.3390/joitmc4030021>
- Li, G., Hou, Y., & Wu, A. (2017). Fourth Industrial Revolution: Technological drivers, impacts and coping methods. *Chinese Geographical Science*, 27(4), 626–637. <https://doi.org/10.1007/s11769-017-0890-x>
- Liu, H.-Y. (2018). The power structure of artificial intelligence. *Law, Innovation and Technology*, 10(2), 197–229. <https://doi.org/10.1080/17579961.2018.1527480>
- Martorana, P. V., & Smith, C. H. (2018). The Pattern in Jade: The Vision of Possibility and the Challenge of a Sustainable Future. *World Futures*, 74(2), 104–115. <https://doi.org/10.1080/02604027.2017.1357981>
- Mauldin, J. (2018). *The Age Of Change Is Coming, And These Tech Trends Will Drive Economic Growth*. Forbes. <https://www.forbes.com/sites/johnmauldin/2018/08/29/the-age-of-change-is-coming-and-these-tech-trends-will-drive-the-next-decades-economic-growth/>
- Metzl, J. F. (2019). *Hacking Darwin: Genetic engineering and the future of humanity*. Sourcebooks.
- Müller-Kirsten, H. J. W. (2006). *Introduction to quantum mechanics: Schrödinger equation and path integral*. World Scientific.
- Munro, W. (1991). Physics and Politics—An Old Analogy Revised. In T. Becker (Ed.), *Quantum politics: Applying quantum theory to political phenomena*. Praeger.
- Peters, M. A. (2017). Technological unemployment: Educating for the fourth industrial revolution. *Educational Philosophy and Theory*, 49(1), 1–6. <https://doi.org/10.1080/00131857.2016.1177412>
- Pfeiffer, S. (2017). The Vision of “Industrie 4.0” in the Making—A Case of Future Told, Tamed, and Traded. *NanoEthics*, 11(1), 107–121. <https://doi.org/10.1007/s11569-016-0280-3>

- President's Council of Advisors on Science and Technology (Ed.). (2014). *Report to the President: Accelerating U.S. Advanced Manufacturing*. Executive Office of the President.
https://www.manufacturing.gov/sites/default/files/2018-01/amp20_report_final.pdf
- Prime Minister's Office of Japan (Ed.). (2014). *Japan Revitalization Strategy*.
<https://www.kantei.go.jp/jp/singi/keizaisaisei/pdf/honbunEN.pdf>
- Reischauer, G. (2018). Industry 4.0 as policy-driven discourse to institutionalize innovation systems in manufacturing. *Technological Forecasting and Social Change*, 132, 26–33.
<https://doi.org/10.1016/j.techfore.2018.02.012>
- Reuten, G. A. (2019). General introduction. In *The unity of the capitalist economy and state: A systematic-dialectical exposition of the capitalist system*. Brill.
- Rodrik, D. (2016). Premature deindustrialization. *Journal of Economic Growth*, 21(1), 1–33.
<https://doi.org/10.1007/s10887-015-9122-3>
- Rojko, A. (2017). Industry 4.0 Concept: Background and Overview. *International Journal of Interactive Mobile Technologies (IJIM)*, 11(5), 77. <https://doi.org/10.3991/ijim.v11i5.7072>
- Schwab, K. (2017). *The Fourth Industrial Revolution* (First published in Great Britain by Portfolio). Portfolio Penguin. <https://luminariaz.files.wordpress.com/2017/11/the-fourth-industrial-revolution-2016-21.pdf>
- Shuo-Yan, C. (2018). The Fourth Industrial Revolution: Digital Fusion with Internet of Things. *Journal of International Affairs*, 72(1), 107–120.
- Srnicek, N., & Williams, A. (2015). *Inventing the future: Postcapitalism and a world without work*. Verso Books.
- Street, J. (1992). *Politics and technology*. Guilford Press.
- UN General Assembly. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. UN.
<https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf>
- Vickers, C., & Small, I. (2018, May 9). *The synthetic biology revolution is now – here's what that means*. The Conversation. <http://theconversation.com/the-synthetic-biology-revolution-is-now-heres-what-that-means-102399>
- Waters, B. (2006). *From human to posthuman: Christian theology and technology in a postmodern world*. Ashgate Pub.