Education and Technological Unemployment in the Fourth Industrial Revolution

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Abstract and Keywords

This chapter explores the rapidly growing body of research around technological unemployment and asks: What is the role of higher education in the digital age when technological unemployment becomes the rule rather than the exception? It shows that educational solutions based on the concepts of human capital and *homo economicus* are unable to resolve the problem of technological unemployment, and concludes that contemporary education requires a non-supercessionist approach based on the figure of *homo collaborans* which fundamentally rethinks the concepts of work, education, and research. Finally, it blends the 'open model of the digital university' and the model of 'creative university as digital public university' with recent insights into technological unemployment and develops the non-supercessionist 'model of education for the Fourth Industrial Revolution' which may serve as a useful point of departure for further discussions in the field.

Keywords: technological unemployment, cognitive capitalism, Fourth Industrial Revolution, homo economicus, homo collaborans, material labour, immaterial labour

(p. 394) Introduction: The Robots Are Coming

THE 2015 World Summit on 'technological unemployment' held in New York on 8 September by The World Technology Network in association with IBM Watson and speakers such as Robert Reich, Larry Summers, and Joseph Stiglitz addressed the issues by highlighting the new raft of disruptive technologies that will allegedly create jobless growth and worldwide unemployment:

> Accelerating technological unemployment will likely be one of the most challenging societal issues in the 21st Century. Never before in history are so many industries being simultaneously upended by new technologies. Though 'creative de-

> struction', in which lost jobs are replaced with new ones, will be a factor, our newest technologies have the clear potential to eliminate many more jobs than we create. With technology advancing at a geometric pace, robotics, artificial intelligence, 3D-printing, and other innovations with enormous disruptive potential will soon hit the mainstream. Billions of people worldwide are currently employed in industries that will likely be affected—and billions of new entrants to the workforce will need jobs.
>
> (The World Technology Network 2015)

(p. 395) Larry Summers (2014) writing for *The Wall Street Journal* suggests the main problem is not producing enough but providing enough work: 'There are more sectors losing jobs than creating jobs. And the general-purpose aspect of software technology means that even the industries and jobs that it creates are not forever.' His views are echoed by the current generation of economists.

Mark MacCarthy (2014) in 'Time to Kill the Tech Job-Killing Myth' acknowledges, 'There is a prevailing opinion that we are in an era of technological unemployment—that technology is increasingly making skilled workers obsolete.' Yet in a contrary mood he is more optimistic choosing to emphasize the long-term relationship between technology and job creation focusing on the software industry that employs some 2.5 million directly and supports job growth in other industries (five new jobs for every ten software jobs).

Others are much less sanguine. Erik Brynjolfsson and Andrew McAfee in *Race against the Machine* (2011) and *The Second Machine Age* (2016) have commented that the computer revolution has huge potential for disrupting labour markets and reducing labour costs. In their latest book they talk of the watershed in robotization and the corresponding increasing capacity and intelligence of digital technologies. Their empirical study led them to three broad conclusions. The first, hardly surprising or informative, is that 'we're living in a time of astonishing progress with digital technologies—those that have computer hardware, software and networks at their core'. They go on to argue for a second conclusion that 'the transformations brought about by digital technology will be profoundly beneficial ones'. The third conclusion is the one posing the greatest challenge:

> digitization is going to bring with it some thorny challenges … Rapid and accelerating digitization is likely to bring economic rather than environmental disruption, stemming from the fact that as computers get more powerful, companies have less need for some kinds of workers. Technological progress is going to leave behind some people, perhaps even a lot of people, as it races ahead.
>
> (Brynjolfsson and McAfee 2016: 11)

In an interview entitled 'The Great Decoupling' McAfee suggests:

> Digital technologies are doing for human brainpower what the steam engine and related technologies did for human muscle power during the Industrial Revolu-

> tion. They're allowing us to overcome many limitations rapidly and to open up new frontiers with unprecedented speed.
>
> (Bernstein and Raman 2015)

Brynjolfsson adds:

> Digital technologies allow you to make copies at almost zero cost. Each copy is a perfect replica, and each copy can be transmitted almost anywhere on the planet nearly instantaneously. Those were not characteristics of the First Machine Age, but they are standard for digital goods, and that leads to some unusual outcomes, such as winner-take-most markets.
>
> (Bernstein and Raman 2015)

(p. 396) If the era of the Industrial Revolution was the First Machine Age, and Electricity the Second, then Electronics was the Third and the Internet as platform the Fourth. In 2003 Marshall Brain wrote a series of articles on the coming robotic revolution. Over ten years later, following the publication of *Robotic Nation and Robotic Freedom* (Brain 2013) he notes the pace of automation has increased with the advent of driverless cars, pilotless drones, and automated retail systems like ATMs, restaurant kiosks, and self-service checkouts. These developments emphasize the emergence of autonomous intelligent systems taking the form of humanoid robots. Moore's law predicts CPU power doubles every eighteen to twenty-four months or so and he documents Intel's release of the 4004 microprocessor in 1971 with a 4-bit chip running at 108 kilohertz and some 2,300 transistors, followed by the first IBM PC in 1981, Intel's first Pentium processor in 1993 (4.7 megahertz with 30,000 transistors), and the Pentium 4 with 1.5 gigahertz and 42 million transistors. Today, supercomputers like the Milky Way-2 has in excess of 300 quadrillion FLOPS (floating operations per second) (see Expert Exchange 2016). The iPhone 6 has more computing power than the Cray 2 supercomputers of the 1980s.

Martin Ford (2009) in *The Lights in the Tunnel: Automation, Accelerating Technology and the Economy of the Future* argues that as technology accelerates, machine automation may ultimately take over the economy creating significant job loss (up to 50 per cent of all jobs in two decades) and a diminished discretionary income for the bulk of consumers.

Technological unemployment is undoubtedly an impending problem that will create greater inequalities and an increasing gap between the returns to labour and the returns to capital. There have been many proposed solutions to this problem including the Luddite strategy of refusing innovation, as well as more progressive solutions based on the provision of welfare and public employment schemes and the introduction of a basic minimum income. Some economists have talked of granting subsidies and grants to small business and the self-employed, the introduction of a shorter working week, and public ownership of the technological infrastructure. Some educators seek a panacea in reshaping the future workforce through the concept of 'critical thinking' yet critical educators such as Henry Giroux clearly show that these efforts are far from enough (Jandrić 2017:

153; see also Giroux and Jandrić 2015). In this general environment, it seems increasingly unlikely that education by itself will be sufficient to solve problems of technological unemployment (see Brown et al. 2011; see also Lauder 2010). In this chapter we assess the limits of educational solutions to the problems of technological unemployment, link them to cognitive capitalism, and rethink the role of education, critical thinking, and innovation in and for the age of digital reason.

Klaus Schwab's Fourth Industrial Revolution

Klaus Schwab, the founder and executive chairman of the World Economic Forum wrote the underlying paper for the economic summit at Davos in 2016, profiling what he calls 'The Fourth Industrial Revolution':

(p. 397)

> We stand on the brink of a technological revolution that will fundamentally alter the way we live, work, and relate to one another. In its scale, scope, and complexity, the transformation will be unlike anything humankind has experienced before. We do not yet know just how it will unfold, but one thing is clear: the response to it must be integrated and comprehensive, involving all stakeholders of the global polity, from the public and private sectors to academia and civil society.
>
> (Schwab 2016)

He pictures the next industrial revolution as succeeding the IT revolution of the 1970s that automated production and he speculates that a fourth revolution based on what he calls 'cyber-physical systems' is the next development paradigm. First an era dominated by steam and mechanical production, what we commonly know as the Industrial Revolution, followed by the mass production paradigm that dominated the electric age, then IT and finally cyber-physical systems that can be seen as a distinct era because of its velocity, scope, and system impact. This is the age of global connections that have the power to transform entire systems of 'production, management and governance'.

The speed of technological 'breakthrough', Schwab argues, has no historical precedent connecting billions of people through mobile devices that have unprecedented processing power, storage, and unlimited access to knowledge. He writes:

> And these possibilities will be multiplied by emerging technology breakthroughs in fields such as artificial intelligence, robotics, the Internet of Things, autonomous vehicles, 3-D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing.
>
> (Schwab, 2016)

What characterizes the Fourth Industrial Revolution is the underlying digital logics that changes everything. While it is the means for massive automation and the decline of industrial jobs it is itself not 'industrial'. This is what Schwab does not understand or theorize very well. An industrial technical system that had its beginnings in England and Scotland with the invention of a refined steam engine that could be applied to the textile industry has now been truly globalized but it is not just the extension of the scope and scale of industrialization that has changed. With each successive wave of technical innovation the logic has undergone fundamental changes in velocity, speed, and scope with an accompanying emphasis on processes of abstraction, formalization, and mathematicization that enable and reward autonomous digital network systems.

Having reached its global limits of geography and the integration of world markets, technology has increased the speed of its instant messaging and communication such that hundreds of thousands of transactions and information exchanges take place at the *speed of light* within the space of a micro-second. Today a single global technical system is emerging that connects and interlocks all major continents with some regionalization in finance, commodities, news, communication, and information. There is a *single planetary technical system* that enables access to global markets in instantaneous real time creating truly globally-scaled markets that dwarf the scale of the first industrial/colonial system and exponentially speeds up all transactions. A fundamental difference is that this single system perfected and refined reaching into every corner of the world no longer works on simple cause and effect and therefore is not linear but rather emulating **(p. 398)** natural systems becomes dynamic and transformative. This demonstrates the properties of chaotic and complex systems that also increase volatility, interconnectivity, and unpredictability. It is in part the consequence of the digital logic that drives the single technical system of 'algorithmic capitalism' (Peters 2012).

Automated cognition is fundamental to digital capitalism (see Boutang 2012; Peters and Bulut 2011). Braidotti (2015) suggests:

> Automated cognition is central to today's capitalism. From the rationalization of labour and social relations to the financial sector, algorithms are grounding a new mode of thought and control. Within the context of this all-machine phase transition of digital capitalism, it is no longer sufficient to side with the critical theory that accuses computation to be reducing human thought to mere mechanical operations. As information theorist Gregory Chaitin has demonstrated, incomputability and randomness are to be conceived as the very condition of computation. If technocapitalism is infected by computational randomness and chaos, therefore also the traditional critique of instrumental rationality has to be put into question: the incomputable cannot be simply understood as being opposed to reason.

Others have provided a critique of 'algorithmic ideology' as a means to understand corporate search engines and draw on algorithmic logics for their distributive power (Mager 2014) and the different spatio-temporalities of automated trading that account for the speed of knowledge exploitation in financial markets (Grindsted 2016). Ray Kurzweil (2006) argues that accelerating technology makes this unfolding era truly different especially with the facility of recursive self-improvement and the cumulative growth of Artificial Intelligence. This is the age of genetics, nanotechnology, and robotics that ushers in the age of singularity, enabling the rebuilding of the world molecule by molecule.

Carl Frey and Michael Osborne's (2013) study examines how susceptible jobs are to computerization. Their empirical work is quite detailed, tracking the probability of computerization for 702 occupations. They argue: 'about 47 percent of total US employment is at risk. We further provide evidence that wages and educational attainment exhibit a strong negative relationship with an occupation's probability of computerisation' (Frey and Osborne 2013: 1). Their conclusion is worth referring to. They write:

> While computerisation has been historically confined to routine tasks involving explicit rule-based activities … algorithms for big data are now rapidly entering domains reliant upon pattern recognition and can readily substitute for labour in a wide range of non-routine cognitive tasks … In addition, advanced robots are gaining enhanced senses and dexterity, allowing them to perform a broader scope of manual tasks … This is likely to change the nature of work across industries and occupations.
>
> (Frey and Osborne 2013: 44)

They find that their model predicts job losses also in the service sector as well as transportation and logistics occupations, office and administrative support workers, and labour (p. 399) in production occupations. As they indicate, 'While nineteenth-century manufacturing technologies largely substituted for skilled labour through the simplification of tasks … the Computer Revolution of the twentieth century caused a hollowing-out of middle-income jobs' (Frey and Osborne 2013: 45). These conclusions ought to be sobering for policy makers and educationalists alike: Where will new jobs come from and what is the purpose for education especially at advanced levels when the covenant between higher education and jobs has been permanently broken? Frey and Osborne (2015) argue that the job stagnation in the digital age can only be avoided by a shift towards inclusive growth. In this frame, a major question becomes how can higher education address inequalities brought on by technological change? With the expanding scope of automation will self-employment become the new normal? In relation to the prospect of transforming education, they write:

> While the concern over technological unemployment has so far proven to be exaggerated, the reason why human labour has prevailed relates to its ability to acquire new skills. Yet this will become increasingly challenging as new work requires a higher degree of cognitive abilities. At a time when technological change is happening even faster, a main hurdle for workers to adapt is thus the surging costs of education.
>
> (Frey and Osborne 2015: 89)

They note the surge in university fees and the spiralling student debt, but argue that the same digital forces at work transforming the future of work can also transform education with the advent of Massive Open Online Courses (MOOCs) and virtual academies. They comment rather optimistically: 'On campus lectures have no pause, rewind or fast-forward buttons, but MOOCs allow students to learn in ways that suit them the best. Students can skip some lectures while attending others several times at virtually no additional cost' (Frey and Osborne 2015: 90). Yet their account is uncritical of MOOCs and forms of online learning that tend to follow the old industrial principles of one-to-the-many broadcast with little interaction and virtually no space as yet for user content (see Gordon et al. 2015; Jandrić 2017; Peters 2013a, 2013b, 2013c).

The MOOCs revolution promises to open up school level and higher education by providing accessible, flexible, affordable courses, using a range of platforms. Fast-track completion of university courses for free or low cost has the potential to change course delivery, quality assurance and accreditation, credentialling, tuition fee structures, and academic labour. Educational institutions need to learn from these initiatives and adopt new business, financial, and revenue models to meet the needs of learners in an open marketplace. Open education brings opportunities for innovation and exploration of new learning models and practices. At the same time universities need to understand the threats of the monopolization of knowledge and privatization of higher education. By contrast they need to look to the prospects and promise of new forms of openness (open source, open access, open education, open science, open management) that promote 'creative labour' and the democratization of knowledge (Peters 2013d). Policy makers need to embrace openness and make education affordable and accessible and (p. 400) also profitable for institutions in an open higher education ecosystem (Peters and Britez 2008; Peters and Roberts 2011; Peters et al. 2013).

We need to understand how 4,000 years of linear writing is giving way to the tele-image (Peters and Jandrić 2016; see also Peters and Jandrić, 2018a); the ways in which digitization as an economic force holds sway over the cultural and the political (Hayes and Jandrić 2014; Jandrić and Hayes 2018); the evolution of new forms of collective intelligence (Jandrić 2017; Lévy 2015; Peters 2015; Peters and Jandrić 2018a) and their political innovations (Jandrić 2017; Peters and Heraud 2015; Peters and Jandrić 2015a, 2015b), to mention a number of the immanent possibilities.

The digital revolution in and of itself will not transform education yet if it does, it will not be entirely for the good. What is required in addition to new digital technologies and the emergence of massive digital systems that operate to centralize power is both political will and social vision to respond to the question: What is the role of higher education in the digital age when technological unemployment becomes the rule rather than the exception?

Education and Technological Unemployment

Recently, one of us visited a telling exhibition on the history of public transport in Zagreb, Croatia (Technical Museum 2017). Tram traffic in Zagreb was established in 1891, and the first job advertisement for tram conductors sought applicants who had completed a minimum of two years of schooling. In 1910 the tram network was electrified, and schooling requirements for prospective conductors were raised to a minimum of four years. Decade by decade, technological developments in tram traffic have been closely followed by increasing schooling requirements for prospective conductors. Finally, a recent job advertisement requires prospective conductors to meet the following criteria:

- High school education in a relevant field (i.e. 12 years of schooling).
- Previous work experience.
- State licence exam.
- Command of one foreign language. (Zagreb.hr 2017)

During more than a century, the work of tram conductors has not changed much—they sell/control tickets, advise passengers about best routes to their destinations, and manage overall passenger experience. Acknowledging technological developments in ticket sales such as barcode readers, however, educational requirements have risen much quicker than job complexity. The rise of educational requirements cannot be explained only by job requirements—obviously, there are other important factors at play such as (p. 401) availability of educated workforce, perceived importance of public transport, and occupational need for protection (through mechanisms such as state licence examination).

During the period of electrification being a tram conductor was a novel, exciting, and well-paid occupation—posters and advertisements from that period depict tram staff as carriers of technological progress. After the Second World War the spirit of novelty has by and large gone, and tram conductors have become respectable representatives of the rising middle class. Finally, with the advent of the knowledge society, the social status of tram conductors has slowly but surely declined. As Zagreb Electrical Tram increasingly digitalizes its services, the job of tram conductors is likely to completely disappear (Technical Museum 2017; see also Frey and Osborne 2013).

Using the case of tram conductors, this brief history reveals the temporal evolution of the interplay between the nature of work, social status of work, technological development, and education. Early tram conductors had very little education and highest social status. Following technological development, each generation of tram conductors was required to undergo more and more education and training; all the while, their social status was firmly situated in the middle class. Finally, tram conductors of the early twenty-first century with historically unprecedented levels of education are being pushed out of the middle class, precariatized, and will probably be soon replaced by the machine. Some of these people will probably retool for occupations created by new technologies, such as working in the central tram dispatch centre. Yet, this solution is not for everyone, as technology continuously lowers the number of required staff per vehicle and per passenger (Technical Museum 2017). In the case of tram conductors in Zagreb, educational attainment has by and large failed to compensate the logic of technological development—more education did not help tram conductors to maintain the declining social status of their work, or indeed the need for their services.

Looking at the employment marketplace at large, things look a bit different. New technologies have created new occupations, and economic growth in the second part of the twentieth century has brought about the following trends:

> In 1940, five per cent of people in the U.S. over the age of twenty-five had finished at least four years of college. By 2013, that figure had risen to thirty-two per cent. At this point, it's well understood that there exists a persistent gap in employment rates and wages between those with bachelor's degrees and those without. On average, those who graduate from four-year colleges are not only employed at higher rates but also earn over fifty per cent more than those with only a high-school degree.
>
> (Vara 2015)

Looking across occupations, and at an individual level, a college degree indeed pays off in terms of employment and wages. Consequently, worldwide government policies have been directed towards increasing educational attainment. This is a prime example of what David Labaree calls educationalization of the problem of employment (Labaree 2008). However, educationalization of technological unemployment creates a vicious circle: as the marketplace becomes flooded with college graduates, the value of their degrees falls. (p. 402) On that basis Vara (2015) and others claim that 'A College Degree Is the New High School Diploma' (Farrington 2014).

Educationalization of technological unemployment is based on the concept of human capital. Its main protagonist, *homo economicus*, is founded in three main assumptions: rationality, which implies making market-based decisions about one's education; individuality, which implies that these decisions should be directed towards individual benefit; and self-interest, which implies that people need to take care of (and be responsible about) their own education (see Peters and Jandrić 2018a). In many cases, *homo economicus* can indeed turn the game of technological development in their own favour. For instance, these days it is generally accepted that pursuing a career in STEM fields (science, technology, engineering, and mathematics) can significantly improve one's chances in the global work market (see Langdon et al. 2011).

By producing more graduates, some companies, cities, and even countries can gain a certain advantage over others. The proverbial case in point is Silicon Valley, where innovation and critical thinking have definitely started to contribute to a more progressive relationship between education and (computer) industry. However, studies in technological unemployment by and large agree that the Fourth Industrial Revolution destroys more jobs than it makes, so advantages created by innovation and critical thinking are necessarily limited temporally and geographically. Without creating new jobs, educationalization of technological unemployment merely creates a new class of 'winners' in the declining work markets. Based on many centuries of experience, it is not difficult to conclude that the largest proportion of the new winners will arrive from the affluent social groups of the present. If we refrain from utopian solution ideas that new technological developments, innovation, and critical thinking will somehow create more work, producing more graduates does not resolve the social problem of technological unemployment—at least not at a global level. In the age of digital reasoning, we do not need more education—instead, we need to fundamentally rethink basic concepts such as education, work, and leisure.

Working in the Age of Cognitive Capitalism

Tram conductors produce tangible service—they sell tickets, show directions, and help passengers to reach their destinations safely and quickly. Therefore, their work firmly belongs to the mode of production characteristic for the era of industrial capitalism. With the development of the age of digital reason, however, production of tangible artefacts and services slowly but surely gives way to production of intangible concepts and ideas. *Cognitive capitalism* is the culmination and most systematic outline to date of an economic theory of a form of capitalism superseding industrial capitalism. Yann Boutang (2012) working with his colleagues in Paris around the journal he established in (p. 403) 2012 called *Multitudes*, builds on the works of Antonio Negri, Paolo Virno, Christian Marazzi, Andrea Fumagalli, and others in the Italian autonomist school of thought to focus on cognitive and 'immaterial' labour.

Under cognitive capitalism a fundamental shift occurs in capitalism from physical resources to knowledge and brain power as both input and output, signalling a break with Fordism and a historically new stage of capitalism, with significant consequences for education and digital labour (Peters and Bulut 2011; see also Peters and Jandrić 2015b). Richard Sennett's *The Corrosion of Character* (2000) describes the enormous difference between the lives of a Fordist worker Enrico and his son Rico, who works in a more flexible and unpredictable form of capitalism. Upon reading the book, one comes to recognize the extent to which the world of work has been transformed. Even though the popular media remembers Karl Marx only during times of crisis, there are vibrant debates among Marxists themselves, regarding the transformation of work and labour processes. We should definitely take Michael Hardt and Antonio Negri into account among the prominent names of this debate. Yet, we believe a historical account of this concept would be useful prior to more contemporary ones.

Leopoldina Fortunati states that Tarde's writings (*Les Lois de l'imitation* [1890] and *La Logique sociale* [1895])

> stressed the existence of other forces (or laws) acting on a socio-psychological level, such as imitation, the law of minimal effort, and innovation. In doing so he argued that the social teleology imposed by classical economists unaware of the true foothold of political economics was at fault for the omission of affections, and es-

> pecially of desire, in analyses of valorization (spheres which were also neglected by subsequent Marxisms).
>
> (Fortunati 2007: 142)

Werner Sombart, on the other hand, in *Modern Capitalism*, argued that immaterial labour was becoming more central to capitalism and laid down three reasons for the technological developments of the time:

> first of all, the objectification of technical knowledge, which ensured a continued control over new ideas or inventions, their transmission and with it the diffusion of knowledge; secondly, the systematization of technical knowledge which allowed for a systematic progression of knowledge and its enlargement; thirdly, the mathematization of technical knowledge.
>
> (Fortunati 2007: 143)

The revival of the contemporary versions of immaterial labour debates can be seen with such scholars as Antonio Negri, Michael Hardt, and Maurizio Lazaratto, and the journal *Futur antérieur*. Nick Dyer-Witheford (2001) provides a smooth historical account of how these debates were chronologically shaped in Antonio Negri's writings on the

> intellectual qualities of a post-Fordist proletariat enmeshed in the computers and communication networks of high-technology were intensified in the analysis of the (p. 404) general intellect (the socialized, collective, intelligence prophesied by the Marx of the *Grundrisse*) developed by the journal *Futur antérieur*.
>
> (Dyer-Witheford 2001: 70)

For a precise definition of immaterial labour, we can refer to Lazzarato:

> Immaterial labor is defined as the labor that produces the informational and cultural content of the commodity. Informational content: related to big industry and tertiary sectors; skills involving cybernetics and computer control … Cultural content: kind of activities involved in defining and fixing cultural and artistic standards, fashions, tastes, consumer norms and more strategically public opinion.
>
> (Lazzarato 2006: 132)

The revival of these reflections reached its peak with the publication of Hardt and Negri's *Empire* (2000).

Underlining the shift from an industrial economy towards an informational economy, Hardt and Negri focus on how the nature of labour has changed within the framework of the Toyota model, as opposed to the Fordist one. In this new phase of global capitalism, 'factories will maintain zero stock' (Hardt and Negri 2000: 290) and immaterial labour will gain significance. Hardt and Negri define immaterial labour as that which 'produces an immaterial good, such as a service, a cultural product, knowledge, or communication' (Hardt and Negri 2000: 290). According to Hardt and Negri, there are three types of immaterial labor:

> one is involved in an industrial production that has been informationalized and has incorporated communication technologies in a way that transforms the production process itself … Second is immaterial labor of analytical and symbolic tasks, which itself breaks down into creative and intelligent manipulation on the one hand and routine symbolic tasks on the other. Finally, a third type of immaterial labor involves the production and manipulation of affect and requires (virtual or actual) human contact, labor in the bodily mode.
>
> (Hardt and Negri 2000: 293)

As far as the rise of immaterial labour is concerned, Hardt and Negri stress a point of departure from a Marxian political economy 'by which labor power is conceived as "variable capital", that is, a force that is activated and made coherent only by capital' and argue that 'today productivity, wealth, and the creation of social surpluses take the form of cooperative interactivity through linguistic, communicational, and affective networks' (Hardt and Negri 2000: 294). Thus, they argue, in this decentralized production, 'the assembly line has been replaced by the network … workers can even stay at home … and these tendencies place labor in a weakened bargaining position' (Hardt and Negri 2000: 295–6). Hardt and Negri, when thinking about this challenge to labour power, argued that production and life have become quite inseparable. That is, in this flexible accumulation regime, 'life is made to work for production and production is made to work for life' (Hardt and Negri 2000: 32).

(p. 405) Hardt and Negri and others' analyses of immaterial labour was attacked for some obvious reasons in the sense that these new circuits of capital 'look a lot less immaterial and intellectual to the female and Southern workers who do so much of the grueling physical toil demanded by a capitalist general intellect whose metropolitan headquarters remain preponderantly male and Northern' (Dyer-Witheford 2001: 71). Despite these sound critiques, Dyer-Witheford acknowledges the increasing hegemony of immaterial labour along with other scholars, including Yann Moulier Boutang, who has neatly classified certain characteristics of cognitive capitalism. Comparing cognitive capitalism with industrial capitalism, Boutang states that 'in industrial capitalism, accumulation concerns mainly machines and the organization of work dealt with … whereas accumulation in cognitive capitalism rests on management of knowledge and production of innovation, hence on immaterial investments' (Boutang 2012: 12). Along with that, Boutang stresses the differences with respect to different entrepreneurs of industrial capitalism and cognitive capitalism. While the former is defined by his/her greed, pride of separateness, and the 'exception of founding father', the latter is marked by the desire for fame and 'pride of cooperation and connectivity' (Boutang 2012: 22).

Here, the issue of cooperation and connectivity directly takes us to the classification we have tried to establish within the framework of this chapter. We have argued that the different capitalisms we have underlined have a lot in common. In this respect, immaterial labour, cooperation, and informational capitalism all have overlapping features. As argued with respect to information, for instance, it is not easy for a single person to control, and is based on networks (Fuchs 2008a). These features all have the potential for collaboration. However, it is exactly here that we might step back and be cautionary in terms of the 'cooperative or emancipatory' for two reasons: political economy and subjectivity. While the former is related to the fact that 'the total assets of the top six knowledge corporations were 1,132,41 billion US dollars in 2007 and are larger than the total African GDP' (Fuchs 2008a: 284), the second has to do with how labour is subsumed within cyberspace thanks to the discourse around collaboration, pleasure, and participation. In other words, what the participation of immaterial labour within cyberspace means has not been endorsed by critical theorists, who have underlined this potential but at the same time pointed to various mechanisms through which subsumption of labour is realized in cyberspace (Fuchs 2002, 2007, 2008b). This cautionary stance is relevant to the realm of education, as well.

David Harvie, for instance, argues that the war over value has not only spread through the factory but there are also attempts to quantify the value produced by immaterial labour, especially within the framework of higher education, including techniques of 'quantification, surveillance and standardization' (Harvie 2000, 2008; see also De Angelis and Harvie 2006). Neo-liberal restructuring of schooling in line with market demands has also resulted in the emergence of a global policy inflation around lifelong learning and educational credentials that are commodified. As the assembly line and certain expected demands from the factory and workplace have disappeared, schooling built around industrial lines has been rearranged, and is asked to train students along the lines of the global knowledge economy and fluctuating market demands. However, (p. 406) the responsibility is between the school and the individual. An awareness of these developments then takes us to the centrality of value creation to capitalism. That is, despite the changing nature of work and labour processes, value still represents 'the life blood of capitalism', in whatever form (Rikowski 2003). As it is also asserted, 'the extraction of value from immaterial labor, much like that occurring at the zenith of Fordism in the automobile factories of Turin or Detroit, is not a friction-free matter' (Brophy and de Peuter 2007: 179).

In this respect, one could argue that immaterial labour is quite material in terms of extraction of surplus value and exploitation and thus analyses based on the concept have to take an approach that is based on a layered and relational understanding of immaterial labour and the differential power relations among the people who exercise this kind of labour in their everyday lives, be it creative design workers or the janitor who cleans their cutting edge personal computers.

Educating for the Fourth Industrial Revolution

Material labour is based on the concept of *homo economicus*—the amount of produced goods, and the level of skill required for producing these goods, is directly related to a worker's income. However, immaterial labour operates in a radically different way. In our recent book, *The Digital University: A Dialogue and Manifesto* we closely examine changes in knowledge production and dissemination in the age of the digital reason and critique the main founding assumptions for *homo economicus* as follows:

> The assumption of individuality is counter posed by collective intelligence … that can take different forms from collective awareness and consciousness, to collective intelligence, responsibility and action. The assumption of rationality is contradicted in a networked environment as the ontological basis is contained in the relations between entities rather than any one self-sufficient entity that is rationally aware and transparent to itself. The network is a very different kind of epistemic set of relations rather than the individual knowing agent. Finally, the assumption of self-interest again tends to be offset or decentred by forms of collective responsibility. In a connected world there are no clear boundaries in either the physical or social worlds.
>
> (Peters and Jandrić 2018a: 343)

Based on this argument, we propose a fundamental shift from the figure of *homo economicus* based on the logic of human capital to the figure of *homo collaborans* based on the notion of creative labour. By creativity, we imply a different paradigm 'as a sum of rich semiotic systems that form the basis of distributed knowledge and learning. This view sees creativity as enabled or permitted by the new digital infrastructures of human culture in the 21st century—primarily technical infrastructure, code, and content' **(p. 407)** (Peters and Jandrić 2018b). We show that the transition from *homo economicus* to *homo collaborans* is rooted in basic questions pertaining to human nature, and the dispute between Darwin's theory of evolution and Kropotkin's theory of mutual aid. 'The struggle between *homo economicus* and *homo collaborans* has always been there, but digital technologies have created a new battlefield and a new opportunity to challenge the traditional order of things' (Peters and Jandrić 2018a: 350).

Education of *homo economicus* is radically different from education of *homo collaborans*—the first is based on spirit of competition, individual achievement, and intellectual rights, and the latter is based on radical openness, peer production, and collective intelligence. Acknowledging the complex and interrelated nature of the two concepts, we have recently developed the idea of the education of *homo collaborans* using two distinct yet overlapping models. In relation to the public role of education, we developed 'the open model of the digital university'.

> This model is philosophically oriented to understanding the emergence of a different kind of institution and its possibilities within the epoch of digital reason. Against neoliberalism and the cult of generic management, the open model of the digital university examines the significance of peer governance, review and collaboration as a basis for open institutions and open management philosophies. Expressive and aesthetic labour, popularly known as 'creative labour', demands insti-

> tutional structures for developing ‘knowledge cultures’ as ‘flat hierarchies’ that permit reciprocal academic exchanges as a new basis for public institutions.
>
> (Peters and Jandrić 2018a: 352)

In relation to epistemology and economy, we further developed ‘the creative university as digital public university’. This model provides a good fit for open science and its economy which replaces linear models of knowledge production by ‘more diffuse, open-ended, decentralized, and serendipitous knowledge processes based on open innovation and technology’, encourages ‘innovation-smart processes based on the radical non-propertarian sharing of content, cloud data computing, and the leveraging of cross-border international exchanges and collaborations’, and fosters ‘a culture of distributed, collaborative, decentralized model research that is genuinely participatory, involving the wider public and amateur scientists along with experts in the social mode of *open knowledge production*’. (Peters and Jandrić 2018b). ‘The creative university as digital public university’ is based on:

(1) User-centred and open-innovation public knowledge ecosystems.
(2) Shared ethos underlying ‘co-production’, ‘co-creation’, ‘co-design’, and ‘co-responsibility’.
(3) New platforms to utilize collective intelligence and commons-based peer production.
(4) Focuses on the links between openness and creativity; design and responsibility.
(5) Radical openness, interconnectivity, and interactivity—shift from industrial broadcast media (one to many) to new social media (many to many). (Peters and Jandrić 2018b)

(p. 408) In response to technological unemployment, the concept of *homo collaborans* underlying our ‘open model of the digital university’ and ‘the creative university as digital public university’ needs to include issues pertaining to work in the age of cognitive capitalism. We need to acknowledge vast opportunities of learning at work; we also need to link these opportunities closer to work markets. Above all, we need to acknowledge that the Fourth Industrial Revolution, at least in the near future, will probably not provide enough work for everyone. However, warn Bayne and Jandrić, our solutions cannot be developed within the existing systems of reasoning:

> The main challenge here is in trying to think about new alternatives not vested in their precursors. That robots are coming to take over our jobs is a very widespread perspective, and has been around for a very long time, gaining new energy recently. In the context of teaching we should not be asking the question: In 50 years from now, will there be a human or a robot teaching? Rather, we should be asking the question: What combination of human and artificial intelligence will we be able to draw on in the future to provide teaching of the very best quality? What do we actually want from artificial intelligence?

(Bayne and Jandrić 2017: 210; see also Jandrić 2017)

Following these thoughts, we proceed to develop the non-supercessionist ‘model of education for the Fourth Industrial Revolution’ which draws on our earlier models of education and recent insights in the field of technological unemployment.

Solutions to a post-work future can be situated between the two main extremes: techno-solutionists, who think that scientific development will somehow fix the issue of technological unemployment (see Allen 2015); and socio-solutionists, who seek for various social remedies such as universal basic income (such as Standing 2011, 2014; see also Standing and Jandrić 2015). Summarizing these trends, Srnicek and Williams reply to the trend of technological unemployment by making four basic demands:

(1) Full automation.
(2) The reduction of the working week.
(3) The provision of a basic income.
(4) The diminishment of the work ethic. (Srnicek and Williams 2015; see also The Real Movement 2017)

While these demands could (and surely will be!) critiqued from many different aspects (for instance, they fail to address important issues such as equality and freedom) (see The Real Movement 2017), they do still represent the main trends in studies of technological unemployment.

‘The model of education for the Fourth Industrial Revolution’ blends Srnicek and Williams’s understanding of cognitive work with our ‘open model of the digital university’ and the model of ‘creative university as digital public university’. According to ‘the model of education for the Fourth Industrial Revolution’, contemporary educational systems should:

(p. 409)

(1) Develop and implement automation as a commons based on peer governance, review, and collaboration as a basis for open institutions and open management philosophies.
(2) Embrace and defend radical openness, interconnectivity, and interactivity, develop user-centred and open-innovation public knowledge ecosystems, utilize collective intelligence and commons-based peer production.
(3) Contribute to the reduction of the working week, based in a shared ethos underlying ‘co-production’, ‘co-creation’, ‘co-design’, and ‘co-responsibility’.
(4) Challenge the prevalent work ethic by focusing on the links between openness and creativity; design and responsibility.
(5) Develop material conditions for just distribution of wealth.

This model acknowledges that the transformation from *homo economicus* to *homo collaborans* is (and will probably never be) complete, and that education cannot resolve the problem of educational employment in its own right. However, by embracing the concepts of radical openness and collective intelligence embodied in the notion of *homo collaborans*, 'the model of education for the Fourth Industrial Revolution' creates a non-supercessionist alternative to the narrow view of education and research through the lens of human capital and triggers some basic principles for developing the present and the future of education and research. Considering the developmental nature of education and research, our model is far less prescriptive than Srnicek and Williams's demands for technological unemployment. For instance, instead of straightforward opting for the provision of a basic income, it speaks more generally about the development of material conditions for a just distribution of wealth. In this way, we believe, 'the model of education for the Fourth Industrial Revolution' provides an adequate blend of recent developments in studies of education, research, and work in the age of cognitive capitalism, and creates an open invitation for creating a more sustainable and a more just future.

Conclusion

Technologies of the present destroy more jobs than they create—and this trend is likely to continue (at least) in the near future. Based on the concepts of human capital and *homo economicus*, emphases on innovation and critical thinking embedded in education, research, and policy measures developed in the framework of industrial capitalism are unable to resolve the problem of technological unemployment. We need solutions which are neither new wine in old bottles nor old wine in new bottles—instead, we need to fundamentally rethink the concepts of work, education, and research. In this chapter, we blend recent insights into cognitive capitalism, the present and future of work, and theories of innovation in the age of digital reason. 'The model of education for the Fourth Industrial Revolution' is based on our past and present experiences, yet it offers a non-supercessionist view towards the future. Acknowledging the never-ending transition (p. 410) from *homo economicus* to *homo collaborans*, it creates a forward-looking framework which enables education and research to actively shape the future of work. The shift from *homo economicus* to *homo collaborans* counterposes individualist understanding of innovation and critical thinking by collective intelligence, rationality by the relational definition of networked (human and non-human) entities, and self-interest by collective responsibility. The digital age is in its very infancy, and 'the model of education for the Fourth Industrial Revolution' is very likely to change in the near future. Therefore, our model does not present a prescription, a blueprint, or a solution—instead, we merely hope that it is a useful contribution to the ongoing discussion about the future of work, education, and research.

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