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Into the digital void?

Martin Upchurch

Technical advances in new information and communication technologies (ICT) have led to debates on the left about the impact of digitalisation on the world of work. Alongside digitalisation and advances in interactive web-based communication, we have also witnessed new advances in robotics, 3D printing, artificial intelligence (AI) and self-tracking technology such as Fitbit or smartphone apps.

In combined form they represent a kind of intensified or "deep" automation that has implications not only for the world of work but for our understanding of capital accumulation strategies. Advances in communication and digital technology are alleged by many orthodox and heterodox economists alike to have a fundamental and positive effect on raising productivity by liberating knowledge-based labour from the rigours of the production process and, by implication, from Karl Marx's labour theory of value. It is suggested that we are entering a new era of "cognitive" or "communicative" capitalism in which "the object of accumulation consists mainly of knowledge, which becomes the basic source of value, as well as the principal location of the process of valorisation"—that is, the extraction of surplus value.[1]

On these views, the "digital economy", as Richard Barbrook postulates, has become a mixture of computer-based networks serviced by "digital artisans"

1 Moulier Boutang, 2012, p57. See also, Dean, 2005.

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often producing and distributing information and knowledge for free as part of a "gift economy" that will pave the way in the future for a new form of anarcho-communism. It is a new era where the accumulation of knowledge usurps the accumulation of capital as the driver of the system. Such a world, Barbrook argues, allows many workers to "escape from the petty controls of the shop floor and the office".[2] Rather than being dependent on a single employer, office space may also be shared in new co-working spaces, where digital artisans, developers, designers and translators hire spaces to conduct work activities that are marketed across the ether.[3]

Alongside the rise of digital labour we have also recently seen the growth of robotics and associated debates on artificial intelligence. The prospect of a world where machines (computers, robots, AI and algorithms) do all the work has been termed a state of "singularity" by commentators from as early as the 1950s. They envisage not only humanless factories and paperless offices but also driverless cars, and homes with robots fulfilling housework and other domestic chores. Healthcare services, it is claimed, might also dispense with doctors as smartphone apps and robots diagnose and treat the sick.[4] "Singularity", as a realistic future, has since been popularised by the futurologist Raymond Kurzweil.[5] In this world our intelligence, it is argued, would become "non-biological" and creativity would be unbounded by human limitations. Machines would dominate production through processes of self-improvement, rewriting their own software to outstrip the functional capabilities of the human brain. Such prospects for machine over man/woman are clearly cataclysmic. So what is reality and what is science fiction?

In this article these debates, old and new, are reviewed, and a Marxist interpretation is presented. The relationship between technology, innovation and capital accumulation is rehearsed, before focusing on computerisation and digitalisation as distinct forms of innovation. Marxist theory, particularly the concepts of socially necessary labour time and abstract labour, helps illuminate the real role of ICT at work. Computers and related technologies are not neutral agents of change; they are rather used by capital as part and parcel of exploitative labour practices and capital accumulation.

Technology and capitalism

Technical innovation can act to reduce unit labour costs by increasing labour productivity to such an extent that it more than offsets the cost of introducing

2 Barbrook, 1998.
3 For a review of unions and co-working see http://tinyurl.com/zb85naw
4 Kirkup, 2016.
5 Kurzweil, 2005.

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the technology in the short term (although as we shall see later the longer-term implications may be different). The drive to reduce unit labour costs and increase worker productivity is central to the competition inherent in the capitalist dynamic, and hence technical innovation is crucial to the survival of individual capitals. Certain technologies have more impact on the world of work than others, sometimes producing a great leap forward in production processes. For example, James Hargreave's spinning jenny, invented in England in 1764, transformed the process of weaving. Steam power allowed railway expansion and the cheaper exploitation of natural resources, and beam engines produced a transformation in textile production. A key example of non-digitised technical innovation in the modern industrial age is the automation of the production line made possible by electronically-controlled (rather than manually controlled) machines. We can point to other technical innovations that spurred processes of urbanisation, such as underground sanitation and water supply, and to other communication technologies such as the telegraph, the telephone and the jet engine that condensed both time and space.

Technology and labour

A consequence of all technical innovation, both old and new, is a degree of labour-shedding as machine replaces individual worker, leading to a parallel rise in the organic composition of capital measured by the ratio between constant capital (itself a product of past or "dead" labour) and variable capital (the "living" labour of workers in the production process). This steady rise of the organic composition of capital was considered by Marx as the key factor in explaining capitalism's tendency towards crisis. This is because it is living labour, the activity of workers at work, that creates new value. Dead labour, embodied in machinery and previously extracted raw materials, creates no new value; it merely passes on its value to the end product in the process of becoming utilised by living labour. As the ratio changes in favour of fixed capital investment in machines, and capital-bias takes effect, the relative share of labour in any one production process is reduced and hence the rate of return on capital investment (or rate of profit) falls correspondingly. So while individual capitals are always forced to adopt technical innovations in order to compete, they are at the same time potentially sowing the seeds of stagnation and decline, by over-reliance on fixed at the expense of variable capital. In order to overcome this tendency, countervailing factors would have to be applied by capital, which might involve attempting to get "more for less" from individual workers.

Hence technical innovation within the capitalist labour process is inevitably a cause of tension, with the promise of strategies of resistance from affected workers. Marx, in considering this tension, related the formation and reformation of

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human society generally to the "change and development of the material means of production, of the forces of production" and thus "the mode of production of material life conditions the social, political and intellectual life process in general".[6] Indeed, resistance by the workers in the dying trades and occupations has often defined both industrial relations and the societal conditions of the age. Most importantly we can observe that the composition of the working population continually shifts and changes as a result of technical innovations. In *The Making of the English Working Class*, E P Thompson elegantly describes such a process of change when he records resistance to the onset of the factory system in cotton based trades. The breaking of the new machines by displaced stockingers and croppers in the late 18th century was "very much more than a particular group of skilled workers defending their own livelihood... Luddism can be seen as a violent eruption of feeling against unrestrained industrial capitalism, harking back to an obsolescent paternalistic code, and sanctioned by traditions of the working community".[7]

Other more recent examples of resistance include the unofficial stoppages by dockers in the 1970s against the technology of containerisation which threw them out of work (the strikes led to the jailing of the Pentonville dockers and the eventual fall of the 1971 Industrial Relations Act).[8] Prior to containerisation ships spent almost half their time in dock, and the sacks and pallets that contained the goods were taken off ship by crane and hooked ashore by individual dockers. Containerisation allowed for mass transit via overhead platforms, onshore storage of goods and direct loading to lorries. It also required deep water ports to accommodate larger ships and make use of economies of scale. As a result of these changes many small ports closed and work shifted seawards away from river inlets to deeper water. The number of dockers in the port districts of East London, for example, fell by 150,000 in a ten-year period between 1966 and 1976.[9]

A more vivid example of the immediate impact of the introduction of new technology came in the "old" media in the 1980s as hot metal compositing and typesetting were replaced by computer-based digital input. The year-long major confrontation between print workers and Rupert Murdoch's News International at Wapping, East London, had been preceded by a union-busting operation led by proprietor Eddy Shah at his *Stockport Messenger* group of newspapers in 1983. Shah successfully used the new anti-union laws to break the union closed shop

6 Marx, 1977.
7 Thompson, 1982, pp599-601.
8 Darlington, 2016.
9 El-Sahli and Upward, 2015, p2.

at his plants and later went on to found a new newspaper, *Today*, produced by computer input.

The Wapping dispute in 1986 was led by Rupert Murdoch against the traditional print unions (the journalists' union, NUJ, had already voted to support the move to the new plant with the few dissenting voices sacked by Murdoch). Some 5,500 men and women working on Fleet Street were dismissed as they struck against plans to shift newspaper production (of *The Times*, *The Sun* and the *News of the World*) to the new plant in London's East End docklands which was fully geared to using new technology. The solidarity picketing at night near the gates of the plant proved unsuccessful in stopping Murdoch as he brought in scab labour with support from the electricians' union EETPU. Disputes such as this one, which followed the defeat of the miners a year earlier, proved to be defining moments in creating new ways of producing and organising work. Spirited resistance from collectivised labour, however, was not always enough to prevent technological change.

So how can we further explain technology as a defining ingredient of the production regime?

Is digitalisation "special"?

We can observe that technology has always been used in the workplace to measure, record and control as a means to maximise value creation and extraction. But commentators from both within and without the Marxist tradition often view digitalisation as a *distinct* form of innovation that produces qualitatively different outcomes on the world of work and value creation. So is digitalisation different from other forms of technical innovation? To answer we must first review the history of the technology itself.

The birth of computerisation

In the late 1960s the first computer-based information systems began to enter the workplace. Computerisation was presented by many as a fundamental break with old technology, allowing for a different world of work based on cybernetics and its associated feedback loops which would enable more efficiency in decision making. Alvin Toffler's best-selling *Future Shock* predicted that the introduction of the new information and communication technology (ICT) would engender a massive transformation of work, entailing the deconstruction of the "traditional" job, or the introduction of more leisure time for workers in aggregate as work "collapsed" and the unemployed drifted into leisure.[10] During the 1970s the fashion for predicting a "leisure society" even infected sections of

10 Toffler, 1970.

the trade unions, most notoriously with the 1979 publication of *The Collapse of Work* by Clive Jenkins and Barry Sherman of the white collar union ASTMS.[11] Suggestions that a fundamental transformation was taking place in work also gathered pace in academic circles with the publication in 1973 of Daniel Bell's *The Coming of Post-Industrial Society*, which predicted a society dominated by service employment and driven by new "intellectual" technology with scientists and engineers in occupational ascendancy.[12] Bell's vision was expanded two decades later by Jeremy Rifkin who foretold the "end of work", and by André Gorz in his postulations of the end of a "wage-based society".[13] The common denominator in all these studies over a 30-year period was an emphasis on the rise of "knowledge work" and its replacement of manual labour and the "traditional" working class. Manuel Castells, in his monumental trilogy *The Information Age*, added grist to the mill of technological determinism and placed information technology as the root of modern social change, arguing that the net would replace the hierarchy as the dominant form of social organisation, and the individual would construct her self-identity within the same technologically based process.[14]

The turn to digital and "immaterial" labour

These debates have taken a new form in the new century to suggest that digitalisation has created a different model of capitalism based on "free" and "immaterial" labour. Tiziana Terranova, in an essay published in 2000, developed an argument that cultural and technical work is integral to the internet, and that much of such work, involving "the activity of building websites, modifying software packages, reading and participating in mailing lists, and building virtual spaces on MUDs and MOOs", is carried out for "free".[15] Digital labour is also identified with a:

> dominant capital accumulation model of contemporary corporate Internet platforms...based on the exploitation of users' unpaid labour, who engage in the creation of content and the use of blogs, social networking sites, wikis, micro-blogs, content sharing sites for fun and in these activities create value that is at the heart of profit generation.[16]

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11 Jenkins and Sherman, 1979. ASTMS was the Association of Scientific, Technical and Managerial Staffs.

12 Bell, 1973.

13 Rifkin, 1995; Gorz, 1999.

14 See Castells, 1996.

15 Terranova, 2000, p33. MUDs and MOOs are online virtual reality systems to which multiple users (players) are connected at the same time.

16 Fuchs, 2010.

The onset of Facebook, for example, is said to rely on the free labour of individual posters to the site, enabling the owners of the site to the reap rewards from advertising sales and revenues. However, there is more to the concept of the digitalisation of work, which stretches beyond the "unpaid" aspects of digital labour. The suggestion is that capitalism has shifted from a system of capital accumulation based on the factory and the collective workplace to one based on the accumulation and dissemination of knowledge through the internet. Hence a shift from "material" to "immaterial" labour.

Some mainstream management theorists have similarly interpreted the rise of networks based on the internet and digitalisation as an opportunity to re-invent organisational decision making structures in the workplace to the advantage of capital. The internet, it is argued, both facilitates and expands the horizons of digitalisation by offering opportunities to "flatten hierarchies and promote open and egalitarian workplace arrangements".[17] Such arrangements are not, however, designed to challenge management prerogative, but are rather intended to tap into worker creativity in the interests of corporate competitiveness. The model is taken further by others, from a left perspective, who champion the levelling effects of digitalisation. Some claim that digital labour, and "prosumption"—production by consumers—will enable a "shared" economy in which consumers create value for companies without receiving wages.

The emphasis on the perceived need to break down binaries and focus on "networks" is rooted in earlier autonomist and Italian *operaismo* (workerism) traditions. This tradition emphasised the primacy of the network and cultural discourse praxis over the economic power of the organised working class. Some, otherwise sympathetic commentators, have tempered this "post-*operaismo*" approach. Nick Dyer-Witheford, in his excellently researched book *Cyber-Proletariat*, for example, proposes a "post post-*operaismo*" perspective. Dyer-Witheford takes as his starting point "neither 'worker' nor 'multitude' but 'proletariat' whereby the proletariat, induced by cybernetics, embraces workers beyond the workplace as the key transformative agency".[18] When combined with robotics and AI the claims for the future become even more gargantuan. Human labour, in this utopian scenario, would be redundant, freeing us all for a life of leisure and a form of anarcho-communism based on cyber networks and shared digital creativity.

If knowledge sharing drives the system then the regime of capital accumulation is fundamentally altered. Most crucially, it is alleged that Marx's labour theory of value would be redundant as machines, computers, robots and AI take over all production. This is the core of the digital labour thesis offered in popular

17 Attwood-Charles and Schor, 2015
18 Dyer-Witheford, 2015

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form by Paul Mason in his book *PostCapitalism* (critiqued in earlier issues of this journal), when he suggests that "knowledge-driven production tends towards the unlimited creation of wealth, independent of the labour expended".[19] This is because of a prediction that the marginal cost of production will be driven towards zero, as "stuff that can be made with tiny amounts of human labour is probably going to end up being free, shared and commonly owned".[20] The "post-capitalist" utopia (or dystopia) that would arise would be a world where the organic composition of capital (enshrined in robot and AI form) had risen so much that the creation of surplus value would shrink towards zero. Carl Shapiro and Hal Varian offer an orthodox economic explanation for this phenomenon suggesting that information is costly to produce but subsequently cheap to reproduce.[21] So the cost of producing the first copy of information may be substantial, but the cost of producing (or reproducing) additional copies is negligible. It is in this "reproduction" phase that the marginal costs associated with digitalisation may tend towards zero as "economics of abundance".

Proponents of the digital labour thesis often refer to Marx's "Fragment on Machines" in the *Grundrisse* whereby he conceptualises the tendency for capitalism to develop productive forces continually through the use of technology. Marx referred specifically to the potential of mechanisation to dominate the production process. The machine appears as an all-powerful force, both in fragmenting the input of the individual worker and engendering a subservient relationship to technology through division of labour:

> But, once adopted into the production process of capital, the means of labour passes through different metamorphoses, whose culmination is the machine, or rather, an automatic system of machinery (system of machinery: the automatic one is merely its most complete, most adequate form, and alone transforms machinery into a system), set in motion by an automaton, a moving power that moves itself; this automaton consisting of numerous mechanical and intellectual organs, so that the workers themselves are cast merely as its conscious linkages.[22]

Marx, however, foresaw mechanisation of the production process not only as a conceptual endpoint of the logic of capital accumulation but also as a driver of alienation, after which liberation could only be achieved by workers taking back power and control of production. Many in the autonomist tradition interpret this endpoint deterministically as the "inevitable" collapse of capitalism, and specifically refer to

19 Mason, 2015, p136. See also Choonara, 2015, and Green, 2016.
20 Mason, 2015, p164.
21 Shapiro and Varian, 1998.
22 Marx, 1973.

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Marx's premise of "communal production", which emerges within this autonomist approach as a particular phase of capitalism where anarcho-communism is enabled by digital artisans. In this interpretation the power of capital, rather than being challenged directly as Marx intimated, is subverted in diffuse forms through networks of the dispossessed. In this supposed nirvana power is assumed without taking power.

Again we can trace the origins of this approach to the Italian workerist movement of the 1970s, which portrayed society as a "social factory" where work had shifted out of the factory, "thereby setting in motion a truly complex machine".[23] Michael Hardt and Toni Negri in *Empire* take the concept further and describe an epoch of "postmodernisation" in which material production has evaporated into a weightless world.[24] Digital communication as an alternative source of information (and the potential power that goes with such information) makes it possible to challenge dominant power structures. Again they argue that there are now no fixed boundaries or territorial centres of power. Instead we are bounded by a world where power lies "both everywhere and nowhere", one dominated by service work and immaterial labour embracing universal cultural "products", knowledge and communication. In this vision intensified use of information technology is once again used as a predictor of a more relaxed, leisure oriented society where menial work is done by machines, labour is collectivised and the division of labour dominant in the era of Fordist mass production is overcome. Marx in the *Grundrisse* is once again misleadingly used to justify such a position.[25]

Of course, we need to be cautious about accepting the idea of postmodernisation without examining the evidence of what has actually been happening in the contemporary world of work. If we simply look at the information technology industry itself, for example, rather than a disaggregated networked form of capitalism, as Castells and others predicted, we find instead a highly concentrated form of capitalism with giant corporations such as Microsoft and Google dominating the industry through processes of exclusivity and buying-up of smaller competitors. The legal regulation of information-sharing favours capital and corporate interests, and laws on intellectual property and corporate confidentiality restrict the ability of dissenters to expose corporate misbehaviour. Facebook is now owned by venture capitalists, while Google has bought YouTube.[26]

This fact that reality is divorced from the rhetoric of the networked and disaggregated form of capitalism is especially highlighted in the case of the so-called

23 Negri, 1989, p92.
24 Hardt and Negri, 2000.
25 See the critique of Hardt's and Negri's use of the "Fragment on Machines" in Callinicos, 2014, pp198-204.
26 Go to http://whoownsfacebook.com/

"app economy" whereby we have the largest taxi company (Uber) which neither owns nor drives taxis, a holiday accommodation agency (Airbnb) which owns no holiday accommodation and a travel agency (booking.com) that arranges no holidays. Furthermore, when it comes to software reproduction we find that Microsoft software updates, for example, are designed deliberately to keep the consumer constantly compulsorily dissatisfied, without choice as to whether or not the older versions should be discarded. Rather than power being distributed, it appears more concentrated in huge corporations in time-honoured fashion as the industry develops.

The concepts of both weightlessness and immateriality have met critiques from the left. Ursula Huws, writing in 1999, questioned the concept of weightlessness, pointing out that: "perhaps one of the most dangerous illusions fostered here is the notion that the new information technologies mean that anything can now be done by anyone, anywhere: that the entire population of the globe has become a potential virtual workforce".[27] The danger referred to is the false notion that work is becoming entirely independent of space, that capital is footloose and super-powerful as a result, and that the collective worker is consequently emasculated. Such notions are suspect even when applied to new phenomena such as the "app economy". Recent disputes involving Uber taxi drivers and Deliveroo's cycle-based delivery agents in London, show us that the material is very real, and that collective strike action can deliver improvements in workers' conditions. Kevin Doogan pursues this point and similarly describes the weightless world scenario as a fallacious concept. The supposed death of distance and time engendered by the ICT revolution has, he suggests, led to an entirely false separation of motion and matter. He argues that in such a vision we appear to move beyond techno-centrism into a world where the transmission of knowledge becomes a fetish in itself. This is despite the important fact that "the production and consumption of knowledge remains materialist even if its circulation is immaterial".[28]

The concept of "free labour" associated with the digital economy has also come under some criticism. Of course, we can all point to *unpaid* time associated with our working lives; simply getting to work by public or private transport is an example. Professional work such as that in education, medicine and the law involves reading documents and learned articles and so on outside of scheduled work hours. It is also true that many features of civil society simply would not exist without volunteer activity: running scouts and guides, organising sports clubs and societies, etc. Much of this involves human exertion, which can be considered work in a general sense, but it is more akin to a labour of love—a hobby,

27 Huws, 1999, p47.

28 Doogan, 2009, p50 refers here to "dematerialisation".

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rather than "free labour" in a postmodern world. More tellingly, as Diane van den Broek has argued in her critique of "free labour":

> digital labour is neither free or immaterial, because it is not the content of labour itself, but rather its relationship with capital that gives it "weight" and value... labour remains heavily bound by an employment relationship and a labour process, whether work is performed in cyberspace or other more "grounded" locations. Indeed, given the mutual dependency between wage labour and capital, both concepts become meaningless without the other.[29]

Let us now move from some of the theoretical disputes and examine the evidence for the transformation of work associated with digitalisation, AI and robotics.

Evidence?

Digital technology, just like previous technological advances, has the power to displace workers. But we need to consider the overall impact of technological innovation in aggregate before we can accept that digital technology will mean the end of work. First, computerisation, while decimating the jobs of typists and hot metal print workers, has expanded work and manufacturing jobs not only in computer hardware and software, but also in mobile phones and games consoles. Second, even the largest operators of the "prosumer" economy, such as Google, Facebook or Amazon, will rely on real-time exploitation of their workforces. In Amazon's case this exploitation is intense within its semi-automated warehouses and outsourced "crowd-workers", whereby workers undertake bite-sized tasks for Amazon on piece rate schemes from home via computer links.[30] Google may rely on advertising revenues from enterprises in the "real" economy for its survival, but at the same time will need to exploit its own workforce in order to compete with rival search engine and email providers such as Yahoo or Baidu.

Third, when we examine the empirical evidence we find that the data do not bear out either the "leisure class" or "end of work" scenarios. In 1975 the industrial sociologist John Child reviewed the available evidence. He rejected the outcome of a leisured or structurally transformed society and concluded that the "logic" of advanced information systems "would appear to extend the routinisation, indeed bureaucratisation of work to clerical and even managerial levels where this may hitherto have been absent".[31] In other words, rather than see the elimination of menial office and manual work we would come to see instead a routinisation

29 Van den Broek, 2010, pp123-124.
30 For a description of Amazon's crowd-working see Knaebel, 2016.
31 Child, 1975, p149.

of work abetted by computerisation. Such a scenario was eloquently exposed by Harry Braverman in *Labour and Monopoly Capital* in 1974, in which he describes the processes of deskilling and Taylorisation of office work.[32] Indeed, the introduction of word processors and the commercialisation of robots in the 1970s sparked concerns not only over routinisation but also over whether or not a "machine was taking your job". A pamphlet on this question written by Chris Harman for the British Socialist Workers Party in 1979 had this to say:

> It is easy to see how the same process of deskilling and increasing managerial control takes place in the store with the introduction of the computerised check-out system. The cash register operator no longer has the excuse when he or she feels tired of taking a "natural break" while they delay to check up on a price; the skilled warehouseman is no longer needed once a computer is keeping a check on stocks and makes out new orders; all the accounts clerk has to do is to read off figures from a computer terminal or print-out. All of them will be left with tasks which are boring and repetitious—and which will get harder as management increases the speed of the computerised parts of the work process.[33]

The onset of mass clerical factories, tied to the computer rather than the filing cabinet, was nigh.

Later historical overviews of the period since computerisation was introduced also point to the same conclusions regarding the falsity of a leisure-based utopia. After conducting a long review of the amassed evidence Peter Bramham found: "with hindsight, the original project around the mission to develop and manage 'leisure society' can be dismissed as naïve".[34] This apparent naivety was undoubtedly driven by a misunderstanding of employer motives for, and consequences of, introducing new forms of technology. From a Marxist perspective, any technical innovation, including ICT and other forms of digitalisation of work, should not be considered as a neutral agent of change within the labour process. Capital will be tempted to invest in new technology not because it may improve the public good, but because it can increase profit ratios. As a result, the utopia of a leisured society under capitalism is illusory. Capital needs innovation to have a pernicious rather than benign effect by intensifying work and increasing the rate of exploitation, not only because of the costs involved, but also because of the necessity for capital to create countervailing tendencies in the workplace to stagnation in productivity growth. Thus, rather than seeing a reduction in working hours in recent decades (in parallel with the rise in digitali-

32 Braverman, 1974.

33 Harman, 1979.

34 Bramham, 2006, p379. See also Veal, 2009, for an additional historical overview of the debates.

sation and ICT) in advanced industrial societies the average hours worked by an employee has tended to increase. This trend sits alongside a general increase in both unemployment and in-work poverty.[35]

Fourth, it is not the case that computerisation and digitalisation have led to a long-term qualitative and quantitative upward shift in aggregate labour productivity (which might give space for the arrival of a leisure society). There will certainly be an initial leap in organisational productivity as a result of the introduction, for example, of newer forms of ICT such as web 2.0. However, such boosts to productivity are not sustained.[36] A study of companies in two countries for the UK-based National Institute for Economic and Social Research confirmed the conclusions from similar studies, that "it seems that the decision of going online does not have by itself long-lasting effects on productivity".[37]

The US-based economist Robert J Gordon is a long-term and mainstream critic of the position that ICT has substantially raised overall productivity. In his latest major study of the US economy he pours cold water on the claim that ICT has had a fundamental effect in raising productivity in the decades since it entered the workplace. Gordon's argument is directed at the "techno-optimists". He states that the IT revolution led to less significant changes in productivity than a host of other technologies including the telegraph, the electric light, or indoor plumbing and urban sanitation.[38] A major point to consider is that computers are a relatively small proportion of capital stock, and that, more significantly, investment in computers has been declining since the height of the "IT Revolution" of the 1990s.[39] The management specialist Michael Porter suggests that, "as all companies come to embrace internet technology, the internet itself will be neutralised as a source of advantage".[40] While upgrades in software and hardware are always likely to occur, the aggregate effect of such upgrading is likely to be small compared to the initial investment. Individual capitals must also consider what Marx described as the "lifespan of fixed capital". As Harman argued:

> Capitalists rarely replace existing machinery the moment technological advance takes place. They try to wait until they have recovered and made a profit on what they spent on that machinery—which usually takes them a number of years. This tendency to wait is increased by risks inherent in being the first to use untried

35 Pradella, 2015.
36 See UKCES, 2014, for a contemporary review of the evidence.
37 Domenech, Rizov and Vecchi, 2015, p24.
38 Gordon, 2016, pp441-461.
39 Goodridge, Haskel and Wallis, 2009, p34.
40 Porter, 2001, p62.

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technology: the chance of scooping the market by a massive reduction in costs can be outweighed by the dangers of the technology simply not working.[41]

Such false dawns of technological change suggest that we need to apply caution to claims of universalism in application.

Robotics and artificial intelligence

Indeed, when examining the evidence, we also find that technical innovation in the form of robotics and AI is similarly restricted in its potential impact on the world of work. Evidence published in 2015 from a dataset of companies in 17 countries gathered between 1993 and 2007 suggests that, while productivity increases with robotic innovation and some semi-skilled and lower skilled jobs are abandoned, "there is some evidence of diminishing marginal returns to robot use—'congestion effects'—so they are not a panacea for growth". Indeed, the researchers suggest further that "this makes robots' contribution to the aggregate economy roughly on a par with previous important technologies, such as the railroads in the 19th century and the US highways in the 20th century".[42]

This is not to say that capital is not investing in robotics. The opposite is the case, as a process of robotic automation is taking place involving artificial cognition and machine learning.[43] Japan and South Korea are leading the way, with over 300 robots per 10,000 manufacturing employees. However, their job replacement value also remains limited, especially given the substantial cost of investment associated with robots. Another problem with investment in robots is that the tasks they can do effectively remain limited. For more complex tasks, robots have to be minded by humans lest they break down or miscalculate precision movements, which once again reduces their potential contribution to productivity enhancement. Mercedes-Benz, for example, has now begun replacing its robots with humans as they are more flexible.[44] Indeed, part of the reason for the limitation of robots in advanced technical processes is their lack of flexibility. A 2016 study of German automotive factories found that instead of providing a panacea for productivity enhancement, the use of robots meant that humans performed extra work which involved constant monitoring of the robots: "during a normal and otherwise smooth shift, a worker responsible for the ballet of eight welding and handling robots intervenes 20 to 30 times per shift—not because of technical

41 Harman, 1991.

42 Michaels and Graetz, 2015.

43 According to the International Federation of Robotics (IFR), the total number of industrial robots in operation worldwide was 1.5 million in 2014, while the IFR expects 1.3 million more to come online in the next two years.

44 See Gibbs, 2016.

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incidents but in order to prevent them. Although human work declined quantitatively over the years, its qualitative role increased with automation".[45] Efforts by a leading robotics manufacturer—Rethink Robots—to create an affordable "plug and play" robot capable of mimicking human movement for widespread use in industry appear to have stalled. The company has recently downsized, announcing redundancies of nearly a quarter of its staff.[46] Moves are now afoot to develop "cobots" as an alternative to robots. These operate side by side with humans to enable flexibility and creativity to flourish.[47]

A second problem, as the Marxist economist Michael Roberts has reminded us, is that robots remain a machine, and as such:

> Robots do not do away with the contradictions within capitalist accumulation...a capital-bias or labour shedding means less new value is created (as labour is the only form of value) relative to the cost of invested capital. There is a tendency for profitability to fall as productivity rises... So an economy increasingly dominated by the internet of things and robots under capitalism will mean more intense crises and greater inequality rather than super-abundance and prosperity.[48]

Furthermore, "a vacuum-cleaning robot, a Roomba, will clean the floor quickly and cheaply and increasingly well, but it will never book a holiday for itself with my credit card".[49] While seemingly trivial, Roberts's comments further highlight the limitations on predictions of a world dominated by robotic innovation. For example, if it were possible to move to a world where robots reproduced themselves (robots making robots making robots) then we would have experienced the mother of transformations to a world of zero profits (as there would be no value creation through human labour), combined with superabundance and leisure with robots akin to slaves. The implications for a contest between capital and labour *en route* to this nirvana would be enormous. As Michael Roberts puts it, "we stand facing a future which might resemble either a hyper-capitalist dystopia or a socialist paradise, the second option doesn't get a mention".[50]

The question of consciousness is also problematic in that we must ask if consciousness transcends artificial "intelligence". When a human looks into a mirror she sees herself; when a monkey looks into a mirror it sees a monkey. But what does a robot "see" and what does it "recognise"? In fact, the robot does not "see" unless it is pre-programmed by human intelligence to record a specific

45 Pfeiffer, 2016, p16.
46 Tobe, 2013.
47 Paul-Choudhury, 2016, p18.
48 Roberts, 2015.
49 Roberts, 2016a.
50 Roberts, 2016b, p10.

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image in distinction from other images. A robot may be programmed to perform new tasks, but it cannot transfer knowledge gained in one task to another. The robot has no imagination, emotion or consciousness and remains a machine. In *Consciousness Explained* Daniel Dennett rehearses this conundrum and argues that computers work very differently from the human mind—computers process increasingly large amounts of information serially, while the mind involves the simultaneous interaction of different mechanisms and processes.[51] The real challenge for AI becomes one of achieving the latter kind of complexity.

What about consumption?

Of course, it is not only in the world of production that automation appears to be gathering pace. As consumers we are constantly bombarded with advertising for new technological products which will supposedly enhance our lifestyle in a "barcode" or "app" society. This may include smart watches, fitness trackers, smart glasses and smart clothing.[52] Google's driverless car has now recorded more than one million miles on Nevada and Californian roads since its launch in 2012, and the UK government, according to media claims, is in the forefront of creating a deregulated approach to their use and actively examining how they may be insured.[53] Driverless cars are not without problems, they are pre-programmed for sets of traffic lights but do not currently recognise temporary lights at road works, nor do they recognise a police officer asking them to stop! Neither are they technically driverless as to date they are only allowed on public roads with a responsible driver with a full licence behind the "wheel". Despite these problems Google estimate they will be clear of such issues by 2020 (or rather that all regulatory hurdles will be dispensed with), while other predatory "sharing" economy companies such as Uber have expressed their willingness to introduce (actually) driverless taxis, clearly on the basis that the need to pay for a taxi driver as well as the taxi can be circumvented.

We are also now able to measure every aspect of our body movements and even our vital signs such as blood pressure and heart rate with wearable devices or via smartphone apps. A whole movement (the "Quantified Self") of people who share and swap such data on a mutual basis has arisen.[54] On a commercial level such quantification and recording of our body movements has, of course, further potential for commodification. In the kitchen a domestic robot may sweep the floor or even record the calorie intake of our food. A sex robot may be of use in the

51 Dennett, 1991, p431.
52 Fordham, 2015.
53 Titcomb, 2015.
54 See Moore, 2014, for a review and Nafus, 2016.

bedroom while for the completely self-obsessed male there is now an app called SexFit which "is worn on the male genitalia to help provide a stronger erection, and connects to a companion smartphone app via Bluetooth or WiFi so that you can measure the important things about a romantic moment, like calories burned and thrusts per minute. The information collected gets sent to your phone".[55]

All of this suggests that we may be moving rapidly to a world where robots, AI and computers become dominant over human inspired activity. However, predictions of the coming of the singularity (when artificial intelligence surpasses human intelligence) are often based on extensions and extrapolations from Moore's "law", named after Intel co-founder Gordon Moore, according to which the number of transistors that can be inserted into a computer doubles every two years, both lowering the cost and vastly increasing computing power. However, there is a finite supply of the rare earth metals used in the manufacture of computers,[56] and Moore has himself acknowledged that there will also be a physical limit to how many transistors you can squeeze into an integrated circuit.

The prospects of reaching the singularity as a result of the application of digitalisation, robotics and AI thus appears a long way off. This is due to the passage of technology that still needs to be undertaken fully to realise the potential of these innovations, but also because of the contradiction between the search for increased productivity and the crisis of profitability that it would entail. These limitations appear confirmed by the evidence. In a major study conducted to assess how likely the singularity is, seven significant tests for its onset observed within the last 50 years were tested. The tests in the study are focused on economic data recording the rates of acceleration in the supply and demand of information technology products such as computer software and related applications, as well as labour related issues of wage growth and productivity in key ICT sectors. The author of the study concluded that "five of the seven tests are negative for singularity while two are positive... Using simple extrapolation for the two positive tests, the time at which the economy might plausibly cross the singularity is 100 years or more".[57] Most significantly, the tests failed on the most important measures of increasing overall productivity and rising wage growth.

In summary we can discern that there appears to be no marked difference between ICT and digitalisation in its effects on productivity, performance and employment within the workplace (and the economy in general) and previous forms of technical innovation. Technology is introduced within the capitalist dynamic precisely to boost labour productivity and reduce unit labour costs, but

55 Amlen, 2014.
56 Go to www.techradar.com/news/computing-components/the-pc-rare-metals-crisis-921363
57 Nordhaus, 2015, p28.

tensions will inevitably arise which mitigate the immediate effects. Most importantly, the contradictions of the capitalist mode of production, seen through Marx's lens of the labour theory of value and the long-term tendency of the rate of profit to fall, still appear to pertain in the new world of digital work. We may well be in the storm of a process of deep automation within the workplace but it is not the case that productivity has been enhanced to a degree that we can foresee either the end of work or a communal utopia of digital artisans in a weightless world of immaterial labour. So can we identify any difference in the world of work as digitalisation gathers pace?

Towards the measurement of everything?

The clue to understanding the real impact of digitalisation upon work and the working class is to re-analyse the effects through Marx's concept of socially necessary labour time. Marx developed the concept of socially necessary labour time to help explain the dynamic of competition between capitals. To succeed in competition with rival capitalists, the individual capitalist is forced to utilise labour to the extent that output per person per unit of time does not fall below the average for the sector or occupation in which the capitalist operates. This average is expressed as the socially necessary labour time required to produce the commodity in question. It is subject to constant change as new applications of technology or new ways to organise and exploit labour power are introduced. Marx explains the relationship between socially necessary labour time and the market value common to all commodities of the same type: "the different individual values must be equalised at one social value, the above-mentioned market value, and this implies competition among producers of the same kind of commodities and, likewise, the existence of a common market in which they offer their articles for sale".[58]

Constant pressure is thus placed on the capitalist to keep up with competitors by revising work procedures and checking that workers are as productive as those of the competitors. The process is all embracing within the dynamic of capitalism. Most importantly, the introduction of new technologies is central to the process not only of increasing individual productivity, but also as a key mechanism to control the worker by enhancing the employer's ability to monitor work outputs in real time. To create maximum efficiency, and to extract the greatest surplus value from our labour, the input and output of all aspects of our physical and mental labour needs to be monitored and controlled by capital.

Marx further conceptualised the process of extracting value from the worker in terms of both concrete and abstract labour. Concrete or useful labour is

58 Marx, 1966.

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the act of working itself to produce a particular kind of useful thing or effect, whereas abstract labour is the process whereby value is created through the equalisation of concrete acts of labour under the discipline of competition (within the dynamic of socially necessary labour time). In identifying abstract labour it is important to understand that Marx proposed that all labour has a dual character and exists simultaneously in both concrete and abstract form. It is abstract labour, however, through which the fruits of our labour are marketised, that is the root of estrangement of the product of labour from the individual labourer. Abstract labour is thus a source of alienation.

So we can expect an ever-increasing drive from employers to monitor, record and control our work, and to establish targets which are standardised across the factory, office, sector and occupation. The ever-increasing quantification of work output which flows from the above dynamic is no doubt the root of the target culture, and other alienative experiences that embrace modern working life, not only in the production process on the factory floor, but also in service and administrative functions. The employers' hunger for measurement stretches into all aspects of our labour whereby no job or occupation seems to escape. Targets are set into our work schedules, and monitored and controlled through competency assessments, appraisals and capability and disciplinary procedures.

The quantification of work is the holy grail of modern human resource practice. It stretches beyond the measurement of physical inputs and outputs into the realm of the psychological, social and attitudinal. In the education sector, for example, Microsoft has prepared a programme that includes a matrix of 39 competencies for "teachers and school leaders". These "competencies" are available to be measured which include such exotic names as "learning on the fly", "organisational agility" and "dealing with ambiguity". For "learning on the fly" alone there are four separate levels of competence from "basic" to "expert" that range over four further sub-competencies.

In this classical perspective we can foresee how the new information technologies are absorbed by capital to pursue its interests through the subordination of labour to its desire for profit maximisation. Thus we can predict that digitalisation will be utilised by capital to extend its ability to survey, monitor, measure and control the work of the individual worker. There is a parallel pathway, encapsulated in the turn towards neoliberal capitalism, which reinforces trends to a more intense dominance of capital by way of its ability to further atomise and individualise the worker so that her "value added" is left exposed and measurable. This neoliberal turn encourages, for example, the abandonment of collectively determined rates of pay, and introduces the prescription of individual performance related pay attached to ever harsher indicators of assessment, capability and discipline. For some commentators, this process of differentiation

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and atomisation has deep social, corporeal and cultural implications whereby we are measured not just in terms of our physical work output but also in terms of our psychological and social inputs.[59]

For others, such as Dyer-Witheford, it may have created the necessity to redefine the boundaries of work and labour by creating a new "cybertariat"[60] or "cyber-proletariat" in which the collectivised worker is subjugated and tempered by the existence of a non-waged pool of potential competitors that expands beyond the factory and office.[61] However, in many ways, of course, such a prognosis is not dissimilar from Marx's and Frederick Engels's original understanding of the reserve army of labour or rather the "surplus population", which may include not only the unemployed and under-employed, but also those who are outside of wage labour or involved at home in the social reproduction of labour. The similarity in concepts thus casts doubt on the uniqueness of the cyber-proletariat vision. Similarly, the "collective worker" is also a concept put forward by Marx as a result of the immediate processes of production. Workers are both subjugated by the employer and collectivised by the process of production at the same time. It is this double dynamic which Marx defined as the essence of the capitalist labour process, and which remains unchallenged by the "digital worker" while the employer continually seeks to exploit and extract surplus value from our labour.

But that is not to say that there are not some aspects of digitalisation that make work different from a pre-digital age. Capital has always sought to measure and control. The first time and motion studies, flowing from the work of Lillian and Frank Gilbreth and Frederick Winslow Taylor in the early 1900s, sought to standardise physical movements within the production process. The Gilbreths even used technological devices such as an electric motor-driven camera and a micro-chronometer to record and pre-determine the "necessary" time needed to undertake a task. Taylor and others such as Charles Bedaux took measurement further, by delving into the physiological and even psychological aspects of matching individual workers to specified work tasks. The movement continued throughout the 1920s and 1930s.

Such forms of measurement rapidly expanded into service and clerical work in the post-war period. Even the simplest work tasks were time measured against banks of photographs created under the Methods-Time Measurement system established in the United States in 1948. These banks of photographs recorded everyday clerical operations, such as lifting a biro or putting a file in a folder, and attached an average expected time to the task. But digitalisation allows for ever

59 See, for example, Moore, 2014.
60 Huws, 2003.
61 Dyer-Witheford, 2015.

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wider and deeper forms of measurement not only in terms of accuracy of our physical output measurable as concrete labour but also as parallel proxies for our value added through abstract labour. These proxies also absorb our *propensity* to add value in the social, physiological and psychological spheres.

For immediate measurement we can list a host of "measurables" that lend themselves to digital recording and instant feedback to the employer. Radio frequency identification (RFID) is utilised by supermarkets to track the movements of warehouse workers, with some companies even insisting on implanting chips into employees.[62] The American analytics firm Sociometric Solutions has supplied some 20 companies with employee ID badges fitted with microphone, location sensor, and accelerometer.[63] Wearable accelerometers or smartphone apps can track individual body movements and even record body language in company meetings for the purposes of "emotional" feedback. These sometimes hidden accelerometers measure your body language and track how often you push away from your desk: "at the end of each day, the wearable badge will have collected roughly four gigabytes worth of data about your office behaviour".[64]

Microphones can record tone and volume of voice and record body language in company meetings for the same purpose. All of these and many other self-tracking devices such as FitBit and Jawbone are available to employers and are being used in increasing numbers.[65] Employers are also using new technologies to record our physical and mental health as an adjunct to predicting levels of performance, but often dressed up under the cloak of "employee wellbeing". Private insurance companies are, of course, itching to structure insurance pricing schedules to such data. Discrete recording systems such as Google Glass may be used at candidates' interviews for jobs meaning the interviewer can record and review the interview and scrutinise responses to questions to assess suitability for specific roles.

As employers search for things to measure and record (consultants are willing to satisfy these desires for a fee) new forms of "competency" assessment allow for psychological assessment and collection of bio-medical scores of neuroendrocine functioning. This, allegedly, makes possible predictions of good "emotional intelligence", ie emotional self-awareness and control.[66] Google has developed a contact lens that will monitor diabetes and glaucoma and has recently submitted a patent for a device that will test blood without a needle. The device works by "sending a

62 Cellan-Jones, 2015.
63 Go to http://slidingdoorcom.blogspot.co.uk/2015/09/spying-in-office-walls-have-ears.html
64 Kimura, 2015.
65 See Moore and Upchurch, 2015, for a fuller exposition of these trends.
66 Boyatzis and Akrivou, 2006.

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surge of gas into a barrel containing a micro-particle that pierces the skin. Once blood is released from the skin, it's sucked up into the negative pressure barrel".[67] The device is wearable and intended to test for glucose. It could potentially be used by employers to monitor employee health. It is in this field of the corporeal that digitalisation could be utilised by capital to intensify employer dominance, allowing, as Peter Fleming suggests, for corporations to express newer forms of "biopower" over employees.[68] Of course, much of this new technology must be considered within the realm of employer fantasy; workers will always resist the tag, the needle or the contact lens in the same way that they have long resisted the time and motion clipboard and the stopwatch. One only has to think back to the introduction of pagers for workers such as telecom engineers as a way of monitoring their "on-call" whereabouts. Many of the pagers "accidentally" ended up in the washing machine and failed to work the next day. The point to understand is that no new technology is "neutral" in its effects once in the hands of the employer, but that its introduction can be resisted.

The intensification of employer dominance over our bodies and selves outlined in this article is a source of our alienation. The control we have over our thoughts and actions is subverted by capital in its own interests. It expands from the physical to the psychological and social, and intensifies the processes of attempted control that began with the time and motion movement over 100 years ago. Such subversion and appropriation will not be left unchallenged as resistance to the imperatives of capital is part and parcel of the structured antagonism of the workplace. Indeed, resistance to management control through technological means has often defined industrial and labour relations throughout history, whether it be auto workers' opposition to Taylorism in the 1930s, or struggles over employer efforts to reduce the "porosity" of the working day ever since. Most importantly, it is important to recognise that the struggle over technology cannot be divorced from the struggle over the control of work. Technology will always be used by capital to reinforce its domination, but can equally be used by workers to create a society not based on profit but on the requirements and needs of society. The battle for control may well, as Marx stated, be the key to human liberation, but rather than being located in the "immaterial", such struggles are firmly rooted in the material challenge to capitalism.

67 Duhaime-Ross, 2015.
68 Fleming, 2015.

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