Where did the Learning Go? Artificial Intelligence, 'Use Sovereignty' and 'Pixarfication' in Factories of the Future

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INTRODUCTION: EVERYTHING CHANGES?

Capitalism revolutionises the means of production but even within this process we hang on to transversal concepts. Workplaces are paradoxically materially different but fundamentally similar in terms of their trajectory over the last two hundred years. Although a 19th-century Manchester factory worker might find it difficult to understand the clean and mechanised Japanese car production plant line, there would be enough similarities to provide some familiarity. The discipline of the clock and of the production process, waged labour and the fatigue of work would hardly have changed at all. In all of this, learning at work could be assumed to be another seemingly transversal concept. The ideas that learning 'on the job' is required to undertake a task and that schooling might be required to deal with written and verbal instructions, as well as the recognition that advanced qualifications are necessary for high-level engineering and technical tasks, have similarities across most cultures and contexts. However, it is easy to mistake these historical and geographical parallels for a timeless universalism in terms of the relation between learning and work.

This chapter takes a critical view of the universalism of that relationship and argues that changes in the workplace, some already underway and other prefigurative changes, are producing a unique shift in the nature and location of learning whilst maintaining fundamental relations between labour and capital. Such changes make learning unrecognisable by even broad epistemologies of human pedagogy and include shifting the locus of learning from humans to products through 'use sovereignty' and the 'Pixarfication' of manufacturing and services, the rediscovery of competence theories of learning and their current alignment with machine learning, and the impact of AI on fragmenting learning entities into the 'skills cloud'. The future is one in which whilst the workplace appears to

be teeming with learning entities where it is difficult to locate learning as we would recognise it, particularly in human workers.

One focal point for this change is the rise in Artificial Intelligence, or AI for short, which has become shorthand for a paradigmatic change in nearly every aspect of contemporary society. Whilst AI may be far from meeting the expectations of most early theorists (particularly in terms of general intelligence), as a tool for significant changes in society it is very powerful. AI is not often clearly specified in accounts of modernisation and it commonly stands for anything from simple computerisation that extends little beyond mechanisation to General Artificial Intelligence (GAI) that would equal or surpass the abilities of the working human. Indeed, fears of an 'intelligence explosion' or 'learning explosion' where an AI entity could bootstrap itself to levels of intelligence well above human sentience abound in our culture. Articles on AI in the workplace in publications such as *Wired* magazine or illustrated in TED talks often present AI as involving an ever-closer linkage with the human. Images of cyborgs or transhuman hybrids abound, not dissimilar from the covers of science fiction magazines of the 1950s. AI often produces 'weird tales' of how humans might come to work in the future. This might involve a close bodily and mental fusion of humans, AI and robots, or the displacement of humans completely by (often anthropomorphised) robots. AI is a hot topic in sociology and education, as much as in business, and the idea that AI could, alongside humans, produce hybrid forms of 'cyborg learning' has become a fruitful line of research in education and robotics. In particular, the field of 'post-humanism' has produced a number of conceptions of how learning can be articulated between humans and other entities such as robots and AI. These conceptions dismiss anthropocentric notions of learning in favour of ones that do not distinguish between or privilege entities, are dismissive of boundary formation and emphasise collective learning properties. In a recent synthesis Hasse (2020) describes post-humanist learning theory as an '… ultra-social collective of social and material collectives' (Hasse, 2020, p. 1). This 'collective of collectives' includes entities of all kinds (Human, robot, AI, animal, material and non-corporal) which are in constant articulation with each other.

For those of us living in the improbably futuristic year of 2021 the future is not quite as exciting as this. Work is still the predominant activity of humans, who struggle continuously to survive in a capitalist society, and the conditions of work have changed very little from early capitalism. Time is still regulated through the clock (Postone, 1993). Our working processes are recorded and regulated so that not a second is wasted in idleness. Research on the quantified self at work (Moore et al., 2017) shows that devices which are used to monitor workers in the contemporary era, ranging from biometric devices to BCI (Brain Computer Interface) technologies, rather than liberating workers from capitalist toil, act to reinforce standardisation. The 'means of cognition' (Dyer-Whiteford et al., 2019) have become a fundamental part of capitalism. Like other 'means of production', the capitalist conversion of human and machine cognition into fixed capital (computers, robots and AI) has increased the scale and scope of capitalist work whilst retaining the same principles of exploitation and the extraction of surplus value from living labour. Although Nick Land (2018), the poster boy for accelerationism, exhorts us not to live in 'transcendental miserabilism' and to embrace the future, the liberatory cyberpunk 'phuture' he predicts does not seem to be on the horizon.

Marxist critiques of the relationship between AI and humanity are not always as optimistic as post-humanist articulations. Despite comments in *Grundrisse* concerning the ability of machine labour to form an alternative to capitalist work (Marx, 1993), in *Capital* machines are largely seen as methods of increasing control of labour processes,

increasing unemployment and exploitation (Marx, 1976). There are similar tensions in other Marxist works concerning the relationship between AI and humans. For example, Dyer-Whiteford (1999) considers that although digital technologies can be used by capitalists to control workers and as a form of 'divide and rule', they also provide possibilities for workers to control production and to create new forms of machine/human hybridisation that might lead to new forms of economic activity outside of capitalism. Bastani (2019) sees technology as an oppressive feature of contemporary capitalism whilst drawing on a number of existing technologies, including AI and post-humanism, to argue that these features of capitalism might enable a 'fully automated' Communist future. Other works are more critical of human/AI hybridisation and communal technologies. Dyer-Whiteford, Kjøsen and Steinhoff (2019) argue that a transhumanist, AI-enhanced workforce would labour under largely the same conditions as current workers, and Griziotti (2019) considers that generalisable technologies that might be expected to form part of a 'digital commons' can be recuperated by capital. These perspectives reflect the duality of optimistic and pessimistic views within Marxism on technology but there is a fundamental tension in Marxist theory in evaluating specific capitalist technology in terms of its emancipatory or revolutionary aspect, particularly in terms of AI/human synthesis. Capitalist accumulation through technology has the ultimate purpose of expanding the creation of 'value' at the expense of human existence, meaning that any form of AI/human synthesis should not be assessed only in its own terms but as part of capitalism as a whole (Kurz, 2014). In many ways such developments are a continuation of current tendencies in capitalism towards the capitalisation of humanity as 'human capital' (Rikowski, 2002). However, although AI might not change the relations of capitalism it does fundamentally change work and workplace learning. Primarily, the position of the human labourer as the locus of learning is irrevocably changed by the reconceptualization of work as an arena of learning entities rather than human beings. To examine this we will first engage in some (near) futurology by examining what the 'factory of the future' might look like.

LEARNING IN THE FACTORY OF THE FUTURE

In the United Kingdom (UK) the EPSRC (Engineering and Physical Sciences Research Council) which is part of UKRI (United Kingdom Research and Innovation) – a government body that allocates competitive research monies to academics – has funded several project to consider what the factories of the future will look like by the year 2030. These projects analyse current technological, social and cultural trajectories to engage in grounded predications of the future in which proof of concept can be shown through actually existing technologies. These projects have involved looking at concepts such as human-based factories which will optimise the production of medications and factories that use materials to produce products which will last forever, adapting themselves to avoid damage.

One of these projects, of which the author is a part, 'Chatty Factories' (Burnap et al., 2019), has profound implications for workplace learning and the role of the human and AI in the production process. The idea of the 'Chatty Factory' is that products (and to some extent services) can already be developed which have human-like capabilities in terms of perception of their environment (through sensors and other methods of recording the nature of their use), communication with the manufacturer (through wireless technologies and internet connection) and sentience or at least some form of so-called learning (through AI or machine learning). This leads to the possibility of 'chatty products' that can communicate with the factory and the

production process. Some companies, such as airlines and some luxury car manufacturers, already use elements of 'chatty products', but as the cost of this technology falls such methods will become ubiquitous and applicable to a wide range of products, even FMCG (Fast Moving Consumer Goods). This change presents a profound challenge to the nature of the current consumer and manufacturer paradigm towards what can be called 'use sovereignty'.

Early factory production was characterised by producer sovereignty, where a usually homogenous product was produced on a mass scale and sold to consumers using standardised advertising and mass marketing campaigns with little product differentiation. This orientation is summed up by Henry Ford's famous maxim regarding the Model T Ford that customers could have any colour so long as it was black. This model had a form of workplace learning where workers were trained for one type of routine or action on a production line, as repetition and consistency were highly important. This producer orientation had implications for workplace learning in terms of the Taylorist nature of the labour process and of training. Work was divided into a series of repeatable actions that were tuned and honed by experts in scientific management, which were then reproduced accurately by humans on a consistently moving production line. Through a finely tuned division of labour a car could be built by using the labour of workers divided by specialism. In terms of workplace learning this had two major implications. Firstly, training was 'preloaded' into human workers through a process of initial learning. There was little formal learning on the job. Taylorism prefigured much of the competence and competency movement in workplace learning (see below). Secondly, there was a need for support for individuals, both inside and outside of the workplace, in terms of learning how to deal with the boredom and repetition of work (which also included how to informally 'game' the system of production). As a result of this, a sociological department was established at Ford to enable families to function more effectively in supporting the (usually male) worker.

The move to consumer sovereignty, heterogeneous products and increasingly customised commodities, led to a Post-Fordist system of production. Post-Fordist production, also known as Toyotism, heralded a system of production where workers would need to be skilled for flexibility and re-skilled for a production line that would require changes to production on a frequent basis. Although in many manufacturing firms the production line remained, and the overall labour process still relied on forms of measurement similar to scientific management, there was a change in the nature of workplace learning. Rather than workplace learning being front-loaded (so that workers were trained in a particular task) and compensatory (to learn formally and informally to deal with the pressures of work), learning 'on the job' and more flexible forms of workplace learning came to dominate the workplace. Workers were expected to reskill and upskill as the production process consistently changed.

In both Taylorist and Post-Fordist production systems there were similarities in terms of workplace learning. Firstly, learning was located at the level of the human and human communities and societies rather than at the level of objects and artefacts. Whilst there was some consideration of human/machine symbiosis in fields such as cybernetics, human factors and prosthetics, the human (even within the framework of a learning organisation) was the locus of learning. Secondly, although contemporary theories of learning that draw on post-humanism, cyborg theory and assemblage allow us to retrospectively reinterpret the human focus of workplace learning during this period, substantively there was always a human focus to workplace learning. Both product (Taylorist) and consumer (post-Fordist) orientations were orientated around a human subject as the 'learner'. This was the case even when an impoverished notion of learning was used

(such as in Competence Based Education and Training - CBET). Thirdly, workplace learning in both consumer and product orientations was based on the idea of an external vantage point or external expertise from education and training experts. Fourthly, work-based learning was a trans-organisational discipline in terms of building a home in universities with a wider connection to the fields of education and pedagogy. Although workplace learning may be adapted differently across workplaces, organisations and countries there was a principle that knowledge could be transferred between contexts. Knowledge of workplace learning was not idiographic and isolated but could form part of a wider body of knowledge.

The 'Chatty Factory' (chatty being UK slang for talkative) model develops a new model of sovereignty, use sovereignty where the use of a product determines its own production (detailed in Burnap et al., 2019). Advances in sensors, technology, cybersecurity, wireless connection (5G), new materials and AI/machine learning mean that products can model human senses and gain a limited sentience (or at least the ability to use machine learning, a form of statistical analysis to determine a course of action or judgement). There are already examples of products which can communicate back to the process of production that might be called 'chatty products'. For example, an airline might place sensors in their aircraft that enable them to receive direct information from aircraft in flight. This in turn allows them, if required, to modify future production. The 'Chatty Factories' model allows for products which collect information about their use 'in the wild'. As the product is used it sends a constant stream of information back to the factory. Using human and AI-based data collection methods the product 'in use' determines its own production. In practice, this process has to involve various methods of mediation. For example, human ethnographers are employed in interpreting the product's use 'in the wild', designers are involved in interpreting the product data when it arrives at the factory, and humans interpret the product data when it is processed into production plans (alongside robots) in the continuous production of the product. 'Chatty Factories' also require a large investment in cyber-security as there are opportunities for data leakage and corruption.

The 'Chatty Factories' model is designed for the factory of the near future (2030), but it is possible to envisage how this might operate in practice today. Imagine that a factory produces bicycles each of which contains a number of sensors that examine the use of the product in terms of location, speed, damage to the tyres and frame, temperature, accidents and final disposal. The use of the bicycle would determine the information sent back to the factory. For example, if the data discovered that products used 'off road' were not robust in terms of the integrity of the tyres then the factory would start to produce bikes which had thicker tyres mitigating the problem. Without human intervention in decision making the production of the bicycle would have automatically been optimised as it is use that has sovereignty rather than the consumer or producer.

This example may seem far-fetched given current technologies but 'Chatty Factories' have proved that the concept works at various stages of the process and is an elaboration of existing tendencies in what has been called 'Industry 4.0' or the 4th Industrial Revolution (Schwab, 2016), in which a variety of technologies such as the Internet of Things (IoT), AI and digital manufacturing are combined to produce a transformation of industrial systems. Despite the advanced technological nature of such systems, it is not necessarily the case that such systems lead to increased worker autonomy (Butollo, Jürgens and Krzywdzinski, 2018), and the 'datafication' of production potentially increases the possibilities for worker surveillance (Beer, 2018; Thomas, Nafus and Sherman, 2018).

Of course, there are differences in the implementation of these technologies in

various industries and the progression towards 'Industry 4.0' may be uneven. However, in the future it is indeed possible that this might be an 'unmediated process' (even with human intervention it could still be considered that the process is assisted rather than enabled by humans). Products 'in the wild' would take in data which would be communicated back to the factory. This 'sense data' would be optimised by an algorithm to maximise profits, which may involve more robust manufacture to minimise faults/returns, reducing costs by minimising redundant features or making the product more appealing to consumers. This would then feed into an automatically adjusted production process. In this way products using AI are 'chatty' in determining their own production. Products and components may also be similarly 'chatty' in the factory, providing consistent and constant data. Through the IoT (Internet of Things) and wireless technology constant communication is plausible. A sophisticated AI may even decide to evolve products to conduct experiments in changing matter through a process which can be called 'speciation', the production of new species and sub-species of products. So in the above bicycle example, a new 'mutant' bicycle might be produced with extra thick tyres to see how it is used in 'the wild'. This is not just a further example of customisation and consumer orientation but a paradigm shift to 'use sovereignty'. Every item in the factory, including robots, AI, components and products inside and outside of the factory, is 'alive' with sense and communication. This whole process of production might be best categorised as Pixarfication, Pixar being a US company that makes movies where toys are sentient (the 'Toy Story' films), robots are sentient (the robots and AI in 'Wall-E') and there is a sense of everything possessing sentience through technology ('Cars') or magic ('Brave'). This pan-psychism of the factory and its products has a profound implication for learning at work.

In the 'Chatty Factory' humans are no longer the locus of learning. The most important learning entity in production becomes the product, which, in conjunction with other non-humans and humans, determines its own production. Learning in the workplace has become a consistent process involving the product as a learning object creating itself in conjunction with increasingly sophisticated forms of AI. The human is not unimportant as they retain a place as an entity in a learning assemblage but their position as the significant learning object has been completely displaced. The subject of workplace learning is now the commodity. How it learns outside the workplace in its environment and how it communicates that learning to other entities within the factory has become the pedagogical question. In this perspective, human learning appears ephemeral. There is now no transhistorical reason to consider learning, including workplace learning, as it is conventionally defined. Capitalism not only appears as Marx said to be a 'mass of commodities' (to highlight the ephemeral nature of the form of value), but this 'mass of commodities' becomes determinant in its own production removing human agency from the process. Of course, in Marxist interpretations the process of production is already inhuman in terms of its determination for profit (which has its basis in the Marxist conception of value) as a real abstraction (Postone, 1993). Here the claim is that commodities literally and directly determine their own production so that the real mediation and abstraction have visceral significance in reality.

COMPETENCE, MACHINE LEARNING AND LEARNING AT WORK

As I have argued previously (Preston, 2017), it is not just the advent of 'Chatty Factories' that displaces humans as the locus of learning. The decentring of human learning is already in progress through the implementation of theories of learning that do not meet the epistemological criteria for 'learning'. In this section I will explain how in combination with the 'use

sovereignty' described previously, this process – in terms of the ways in which CBET and machine learning are becoming entwined – would further remove the locus of workplace learning from the human subject.

Competence models of learning are focused on the outcomes of work, reducing human actions to a series of behavioural responses that are required to fulfil a task. Although competence aggregates poorly to the sorts of collective processes which would occur in workplace learning, there is no reason why competence could not apply to a collective or group of humans rather than a single human. In some ways, competence-based learning's anti-humanism lends itself well to its implementation at aggregate level as it is concerned with outcomes rather than their correlation with specific embodiments. A behavioural outcome can theoretically arise from a competence held by a collective amalgamation of bodies and minds. Indeed, one of the problems of competences is that they are 'nowhere', as the lack of specification of mechanisms means that we do not know exactly where in the body or mind they are located (Preston, 2017). Competences are associated (correlated) with the presence of the competence holder but the location or mechanism of their existence is unspecified. The person who holds the competence might be followed everywhere by a 'competent ghost' who performs every task for them, for example. Although this example might seem ludicrous, the lack of specificity of mechanisms for CBET allows us to account for any possibility.

Competence Based Education and Training (CBET) has been primarily critiqued for its neglect of the affective and cognitive basis of learning. In terms of learning at work, this has particular implications as the affective (social) and cognitive aspects of learning are especially germane to considerations of work-based learning. However, CBET is not only deficient in terms of certain aspects of learning but it simply does not meet the minimal epistemological standards to be counted as learning. Competence is solely concerned with performance of the outcome, but there is no theory or mechanism as to why an outcome might be achieved. Therefore there is no model of learning in terms of the transmission of learning via an embodied entity (presumably) through which an outcome might be achieved. The entity that completes the task (perhaps a 'competent ghost' as discussed above) might achieve the task through consistent luck or magic (Preston, 2017). Neither of these mechanisms are correspondent or correlated with learning. Epistemologically, CBET makes no knowledge claims in terms of the nature of these mechanisms, including learning (unless it adopts an ad-hoc theory of learning from another field). Competence is not 'nonsense' as it makes perfect sense at work in a capitalist economy whereby outcomes are of paramount importance in terms of labour power, but it is not a theory of learning, including a theory of workplace learning.

The paradoxical distaste for learning in general, and workplace learning in particular, within CBET allows competence to be captured in terms of other forms of learning usually associated with AI and robots, such as machine learning. Machine learning is the collective name for a series of techniques that involve statistical processes in the optimisation of a system such as the correct identification of a human face (in terms of pattern recognition). There are a number of machine learning techniques, such as supervised and unsupervised machine learning, swarm learning and discovery learning. In machine learning the discovery mechanism is explicit although epistemologically it may not be 'learning' as it involves discrete optimisation through statistical techniques. In some situations, though (perhaps when embedded in an AI), machine learning may approximate processes associated with human learning (at least in terms of results), and in limited fields surpass them. The reliance on statistical techniques means that machine learning is concerned with what is measurable and observable. In terms of workplace learning, competence and machine learning both move

the locus of learning towards AI and robots. It is AI that 'learns' about the workplace (through machine learning). Humans are abstracted into a set of outcomes (most likely competences). Workplace learning in human terms does not exist as the human is no longer a 'learning entity' in a meaningful way.

Competence considers the specificities of outcomes, rather than how the work relates to the biological, social or cultural potential of the human. It considers that the axiological potential of the human in the workplace, or in work-based learning is potentially open to infinite specification in terms of the outcomes desired by capitalists. It is therefore one possible form of labour power production which is particularly allied with the capitalist production process (labour process), particularly where this is dependent on machines. As Marx specifies in *Grundrisse* (Marx, 1993), workers become the opposite of learners, existing only as the peripheral organs of a machine, producing a repeated 'outcome' that can be measured and optimised by other processes. Of course, in practice there will be worker autonomy and some spaces for worker organisation, but these are ignored and optimised by a process that is determined by outcome-based approaches (competence and machine learning).

AI AND HUMAN COMPONENTS

Relating outcomes to competences, which are then optimised through machine learning, and the rise of 'use sovereignty' are ways in which learning is displaced from the individual worker and increasingly from work-based learning in terms of collectives of workers. Paradoxically, learning seems to be occurring everywhere in the contemporary factory but it is not happening at a human level as epistemologically CBET and machine learning are distinct from what we would understand by learning. This displacement of learning might occur not in terms of a single computational or organisational 'mind' co-ordinating activities but rather as a system of AIs and machine intelligences that collectively seek to optimise profit and cost functions determined by the employer who 'wireheads' these into the organisation. In terms of human outcomes, AIs work to build up a 'grammar' of outcomes, behaviours and combinations. This is the new 'scientific management' where humans are 'chopped up' into outcome entities, either individually or collectively, foreshadowed by Marx in *Grundrisse*:

> The worker's activity, reduced to a mere abstraction of activity, is determined and regulated on all sides by the movement of the machinery, and not the opposite. *The science which compels the inanimate limbs of the machinery, by their construction, to act purposefully, as an automaton, does not exist in the worker's consciousness, but rather acts upon him through the machine as an alien power, as the power of the machine itself*. The appropriation of living labour by objectified labour – of the power or activity which creates value by value existing for-itself – which lies in the concept of capital, is posited, in production resting on machinery, as the character of the production process itself, including its material elements and its material motion. The production process has ceased to be a labour process in the sense of a process dominated by labour as its governing unity. *Labour appears, rather, merely as a conscious organ, scattered among the individual living workers at numerous points of the mechanical system; subsumed under the total process of the machinery itself, as itself only a link of the system, whose unity exists not in the living workers, but rather in the living (active) machinery, which confronts his individual, insignificant doings as a mighty organism.* In machinery, objectified labour confronts living labour within the labour process itself as the power which rules it; a power which, as the appropriation of living labour, is the form of capital. (Marx, 1993, p. 693, my italics)

What is relevant in the above quote is not just how machinery colonises labour (the 'acting upon' of machinery) but also how labour unity both between and within the individual labourer is 'scattered' among the individual workers. As the British philosopher Nick Land describes the process of AI takeover in industry:

> Modern production seems like a dream of cyborg colonization work, a dream that makes the nightmare of Taylorism seem idyllic.
>
> Industrial machines *dismantle the actuality* of the proletariat, displacing it in the direction of cyborg hybridization, and realizing the *plasticity of labour power*. The corresponding extraction of *tradable value from the body* sophisticates at the interface, *dissociating exertion* into increasingly intricate functional sequences, from pedals, levers and vocal commands through the synchronization of production-line tasks and time-motion programs, to sensory-motor transduction within increasingly complex and self-micromanaged artificial environments, *capturing minutely adaptive behavior for capital*. Autocybernating market control guides the *labour-process into immersion*. (Land, 2018, p. 435, my italics)

Here Land takes further Marx's 19th-century considerations of what is happening to labour in the process of industrial production. Labour in all its forms (mental and physical) becomes 'dismantled' into discrete components through AI realising the myriad ways in which it can be combined (its plasticity) where human behaviour is captured. In each of these quotes, the idea is that labour is consistently pushed to the limits of human embodiment as it becomes captured by machinery into a 'grammar' of human labour far surpassing the ideas of scientific management. In these scenarios learning at work does not exist within human entities but in 'chopped up' human assemblages that would be integrated with machines and data in many different forms. The learning takes places within various AIs in terms of a 'skill bank' whereby various entities would be charged with 'producing' types of behaviour. As stated above, this would be an impoverished conception of human learning where learning would become reconceptualised as pure outcome.

INTO THE 'SKILLS CLOUD'

In the field of consumption, AI is already building up data on our behavioural patterns through platform capitalist tools such as Facebook, Twitter and Google. Reactions and behaviours are quantified and used to build up a profile not only of our individual behaviour but of a model of human behaviour. Existent disciplines such as Psychology and Sociology in universities appear to be rather insignificant compared to how accurately social media giants can predict (and modify) attitudes and behaviours based on the predictions of 'Big Data'. In the workplace, quantification also gathers and uses data on how workers behave and respond. As considered above, in many ways this is an extension of scientific management whereby the movements of workers were laboriously logged and tested in a series of scientific experiments. Photography was used to map and chart each human movement as part of a production process so that each factory worker was subject to optimisation and eventually computer technology developed more complex techniques of process and production management which were used to record and simulate worker behaviour. As technology improves, modes of quantification have become increasingly extensive (Moore et al., 2017). High performance digital cameras and sensors are used to record worker movements at sub-perceptual levels. Smartwatches can record worker biometrics and allow instant feedback on worker attitudes. Worker interactions and vocalisations can be measured by using *Alexa*-type devices in the workplace. Employee sentiment can be measured by conducting text analysis of their social media posts. Such devices can also be used to measure worker resistance (including union organisation) and the worker's capacity for disruptive activity. These are all forms of worker surveillance. Through these means, labour power production is becoming even more extensive to reflect not only a wider variety of physical and mental attitudes and behaviours, but also worker attitudes and emotions. Compliance and satisfaction can be measured not only through a periodic worker satisfaction survey but constantly and

consistently during every moment of an employee's day.

This is not just a process of quantifying each individual worker, it also involves building up a model of human behaviour in general. Zuboff (2019) argues that 'Surveillance Capitalism' is not just a method of increasing productivity in certain circumstances but also a method for producing a residue, or surplus, from these surveillance activities in which workers are dispossessed of skills. Zuboff refers to this activity as 'behavioural surplus':

> Surveillance capitalism begins with the discovery of behavioral surplus. More behavioral data are rendered than required for service improvements. This surplus feeds machine intelligence – the new means of production – that fabricates predictions of user behavior. These products are sold to business customers in new behavioral futures markets. The Behavioral Value Reinvestment Cycle is subordinated to this new logic. (Zuboff, 2019, p. 97)

Zuboff primarily considers the realm of consumption in her analysis of Surveillance Capitalism, but it is also possible to apply this work to the behavioural surplus acquired in the workplace. Surveillance produces streams of data which can be combined with other data pools and resources to produce (through machine learning) insights into aspects of human labour that could not be gained by a single observation alone. Owners of this data (who might not be the employer who uses the technology) can create new ways of understanding the mechanisms of worker productivity and the 'nudges' by which the labour power of workers can be enhanced. These can be combined with AI knowledge of other entities in the production process to specify minute interactions between those entities to optimise production. This is what Zuboff (2019, p. 97) refers to as the 'Behavioural Reinvestment Cycle', whereby behaviour is used to build platforms that are reintegrated into the production process to further optimise worker behaviour. One existing example of this is the use of so-called 'fatigue functions' to optimise human performance in production. A 'fatigue function' is a mathematical equation derived from empirical observation which shows when a human worker is reaching the point of 'failure' in terms of being unable to carry on with their task successfully. At present fatigue functions are usually determined by using existing data on worker fatigue so that a production process can be optimised. Studies which have tested worker fatigue in real manufacturing environments under experimentally controlled conditions can be used to specify how workers should behave in reality. With the advent of consistently gathered biometric and behavioural data on workers in real time, fatigue can be measured consistently, and the worker is consistently experimented on by AI that can 'nudge' workers towards better performance. The accumulation of intelligence through surveillance on each individual worker is reinvested constantly into a superior system.

It must be noted that the idea of an intelligence that can catalogue and build a grammar of individual skills and capacities to be used in the workplace is not a new one. The early years of the Soviet Union produced a number of experiments in creating a catalogue of human skills and abilities, with their origins in the work of Alexi Gastev. Gastev sought to record and catalogue all manifestations of physical labour (Ings, 2016, p. 79) which could be combined in a 'performance'. Through this manual cataloguing performances could be choreographed, and workers would learn through rehearsal to prepare for factory work. In the 1980s there were similar attempts in terms of CBET to create a universal database of competences that could be used for any occupation. Plans were made for a vast lexicon of computerised records which could be used to select exactly the right set of competences for a particular work task (Preston, 2017, p. 34). These early experiments foreshadow the contemporary situation where individual behaviours are under surveillance and disaggregated, but the essential difference is that learning is transferred from the worker to the AI, and that the real learning that takes place in the workplace

is occurring at the level of machines rather than at the level of humans.

This evolution and confluence of workplace learning with AI and machine learning is increasingly making the prospect of 'cloud-based' services for skills more likely. Rather than individuals possessing knowledge of discrete skills, the organisation uses 'Behavioural Value Reinvestment' to create a consistently evolving learning platform regarding worker behaviour. However, there is no reason why this evolving knowledge of skills and abilities should remain at the level of the individual organisation. As is the case with other services which can be accessed by a digital organisation, there are plans for 'skills clouds' whereby employers of various types could 'draw down' the particular skills components that they require in their workplace. For example, Workday, a NASDAQ-listed company with a market capitalisation of $40 billion, has produced a 'skills cloud' system that uses machine learning to categorise skills between organisations on order to form a common 'skills language':

> *Cristina Goldt, vice president, HCM products, Workday commented: 'Nearly every organization wants to develop and reskill their workforce to grow their people and their business, but they lack a fundamental understanding of the skills they have and the skills they need. Our skills cloud tackles this issue head on with machine learning algorithms that bring calm to the chaotic language of skills. This will ultimately help customers connect skills to people in a more meaningful way to improve how they get work done, develop existing workers, and allocate talent to better meet evolving business needs.* (Source: www.enterprisetimes.co.uk/2018/10/03/workday-unveil-skills-cloud/)

The capacity for 'skills clouds' to grow is not only premised on technology but also on the growth of new forms of precarious employment. Recruitment agencies, who often act to 'sift' employees to large employers make use of skills tests, using AI and machine learning, to filter workers into job positions and in doing so gain wider behavioural knowledge of worker skills and abilities. Similarly, the growth of 'platform capitalism' in terms of employers who use mobile applications to track and reward workers (such as Uber or Deliveroo) gain constant data on employee behaviour and skills. This leads to a number of separate 'skills clouds', with the possibility of amalgamation at a higher level. The implication of this for learning at work is clear in that learning is disappearing not just from workers, but potentially also from employers as it is integrated into the 'skills cloud' by multinational companies.

CONCLUSION: WHERE IS LEARNING NOW?

As this chapter has shown, through the application of new technologies and systems of organisation, the whole workplace is constantly learning and has evolved into a form of workspace learning where every interaction by any entity is transformed into a learning relationship, but it is not certain that humans will be a key part of this relationship. As has been argued, reducing learning at work to a purely behavioural output (as in CBET) leads to an epistemological position where it is not certain that human learning actually exists. As behaviours are consistently refined and recalibrated by products (through use sovereignty) and AI and machine learning, the 'learning' which occurs in the workplace is consistently being pushed to places other than the embodied human. As shown in the last section it is not even certain that learning in the future can be located in a coherent human body, or even a learning entity in a workplace, as it will have transcended embodiment into the 'skills cloud'. In these ways the solidity of learning in the workplace is being diffused into air. This is in many ways a crisis for the relationship between learning and the workplace in that the traditional humanist basis of this connection is being destroyed, or at least it is being determined and articulated in a different way. This may lead to a fundamental

articulation of learning and work in a different form to conventional humanist ways of understanding. There are already attempts to construct new theories of learning based on post-humanist and new materialist understandings which do not privilege the human-centred nature of learning. In particular, the idea that learning and education could be expanded to take on the status and learning states of all other entities (humans, animals, machines, AI and algorithms or human and nonhumans) has been adopted by Snaza and Weaver, 2016:

> The current subject-object orientation has created what we call a methodocentrism in which the methodology of a researcher and their faithfulness to a method is the primary concern of most research. Methodocentrism relegates most humans and other sentient beings and nonsentient objects to a subordinate position in which the role of these beings in their own reality and other realities is removed from the researcher[']s work …
>
> There are always interactions between humans and nonhuman sentient beings and humans and nonsentient objects, such as computers, doors, playgrounds, hallways, utensils, trays, balls, windows, desks and so on. (Snaza and Weaver, 2016 p. 9)

Although research in this area has mainly focused on schools rather than workplaces it is unarguable that post-humanism and new materialism have created new ways in which the relationships between the workplace and learning have been examined. However, there are grounds to question this new ontological and epistemological approach. Part of this critique is the retreat from anthropocentrism in that it is currently difficult to argue for a human-centred understanding of learning at work (including in terms of worker resistance) without it being considered regressive. Even so it is still necessary to examine how and why, in our current historical formation, the human has been displaced so viscerally from workplace learning, as has been argued in this chapter. To be clear, the problem with using what might be called 'flat' ontologies which do not allow for a distinction between learning entities is that it privileges 'flatness' above 'flattening' ontological perspectives. Denying 'methodocentrism' allows for an ontological slippage in how we examine entities. How humans have lost their ontological status as learners in the workplace and the particular processes through which this has occurred are 'flattening' processes which need to be interpreted within a specific historical context. For example, the ways in which 'value critique' (Kurz, 2012, 2014) explains the subsumption of all existing forms into capitalist 'social forms' is a powerful way of understanding how human labour becomes inhuman capital through what is definitively a 'flattening' ontology rather than a 'flat' one. This also applies to epistemological questions. In principle, learning as a metaphor can be applied to any entity. A kitten learns to be born through the action of biological processes, a planet learns to move through the solar system by the forces of gravity and a cup of coffee learns how to be consumed through its interactions with our lips. In applying learning so widely we lose something of the meaning of the term and we are using it metaphorically for what are really biological, physical and mechanical processes. Although the heresy of this move is appealing, as it opens up new ways of thinking about what learning is, it also removes clarity in terms of distinguishing learning from other processes. As has been discussed in this chapter, the idea of learning being related to a clear mechanism of internal change is important for any conception of learning at work if it is not to be confused for other processes such as the magical or inconsequential.

Post-humanist and new materialist theories might allow us to consider a utopian vision of the future of human learning where we learn with a bestiary of other entities in constant communication but, within capitalism, the workplace is likely to be less utopian. This chapter has tended towards a dystopian vision where the workplace is the 'means of cognition' (Dyer-Whiteford et al., 2019) stripping workers of skill and humanity. Of course, there may be counter-veiling tendencies to this which can be explored in future

analysis. In particular, some of our initial analysis for the 'Chatty Factories' project explores how different organisational contexts such as workers' co-operatives and 'skill share' platforms might adopt different ways of configuring the relationship between humans, robots and AI, although ultimately even these organisations are bound by the tendential qualities of capitalism. Another arena of exploration might be places of resistance. One of these is informal learning at work, which takes place in settings as organised as trade union meetings and as disorganised as canteens. One of the important features of capitalism is that it is consistently failing, especially where it appears to be most successful. For example, as value becomes more prevalent as the 'social form' of capitalism it consistently undermines itself by accelerating production to de-substantiate itself (Postone, 2017; Kurz, 2012, 2014). There are therefore always gaps and spaces in which workers might regain their sense of themselves as learning entities. The flipside of new technologies which make workplace surveillance easier, for example is that they create the conditions in which workers can organise and communicate between unions and even nations. Another aspect is the 'gaming' of mechanised systems at work whereby workers can learn to subvert and work against the algorithms and devices which attempt to organise and control their work, as they have done for centuries. All of this implies that resistance, human subjectivity and ethics are going to be a major part of the discourse of workplace learning, even in the age of 'use sovereignty' and AI.

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