17th Annual
Engineering
Project
Organization
Conference

Working Paper Proceedings

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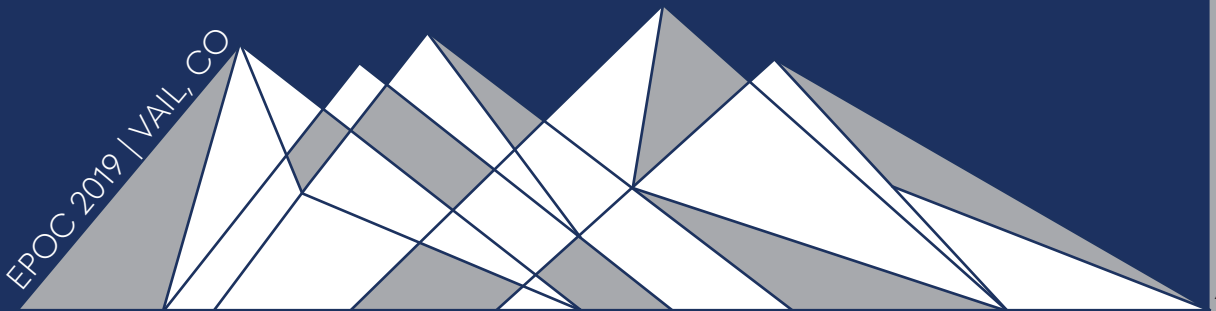

VIVE LA RÉVOLUTION! BUT WHERE IS THE WORKER IN CONSTRUCTION 4.0?

Fred Sherratt[1], Chris Harty[2] and Simon Sherratt[3]

ABSTRACT

Construction 4.0 is bringing change to our industry through digitization and technological innovation. Yet technology is not neutral. It brings with it autonomy and an amorality that is potentially cause for concern. Here we draw on Ellul's theory of technique, as associated with technology, to briefly unpack Construction 4.0 from the perspective of the workers, as exemplified by the EPOC Grand Challenges of social well-being and social value. We suggest that Construction 4.0 is building upon an existing discourse of the 'invisible construction worker' (Ness 2009) and despite the rhetoric surrounding our industry of the future, this worker is challenged by such technologies as well as the digital divide. By raising such concerns we hope to stimulate discussion and debate, and the development of a critical voice to supplement the technocratic optimism that currently dominates Construction 4.0. As the pace of technological innovation continues exponentially, it is important to remember the role our industry also plays in global society, and that any unintended consequences of this fourth industrial revolution are mitigated through a robust research agenda and ethical professional practice in keeping with the Grand Challenges of EPOC.

KEYWORDS

Construction 4.0, innovation, technology, technique, construction workers

INTRODUCTION

We are currently experiencing the fourth industrial revolution (4IR). Industry 4.0, as it is also termed, has been catalysed by the increasing use of technologies within industrial processes, such as robots and additive manufacturing, and supported by digital data, connectivity and cyber systems (McGregor 2017). This integration of manufacturing with information and communication technologies (ICTs) is changing industrial behaviours and impacting both products and processes, as well as transforming project, organisational and wider industry structures. Industry 4.0 brings with it promises of reductions in material, labour and processing costs, and consequential improvements in productivity and efficiency (Dalenogare et al 2018).

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Such promises not only find excellent fit with contemporary economic thinking, but also resonate with the construction and civil engineering sectors, which have long been accused of low productivity, low predictability, and a lack of collaboration, improvement and innovation (e.g. Farmer 2016). For example, the UK construction industry has been the subject of decades of reform-focused rhetoric (Green 2011), and innovation in all forms has long been championed as necessary to resolve issues of inefficiency. Industry 4.0 has therefore found a highly hospitable audience, and 'Construction 4.0' has emerged as a revolution in its own right (FIEC 2017).

However, technologies mobilised to support innovation are not necessarily neutral (Ellul 1954), and inevitably bring both intended and unintended consequences to practice. In this paper, we critically consider the impact of Construction 4.0 through Ellul's lens of technique, and then look to place the construction worker front and centre. Critical challenges of accepted norms often highlight ethical concerns (Smiley et al 2014), and we aim briefly explore this by asking 'where is the construction worker in Construction 4.0?' Although Construction 4.0 as a concept did not exist when the Grand Challenges were first formulated by EPOC in 2009 it has arguably already changed, and will continue to change, engineering project organisation in the future. It is therefore timely to reinforce the need for recognition and reference to the workers, as noted by the social well-being and social value dimensions included with in the Grand Challenges, and here we present ideas for discussion and argue for the development of a critical voice to supplement the technocratic optimism that currently dominates our industry and our current research agendas around Construction 4.0.

CONSTRUCTING THE REVOLUTION

INDUSTRY REFORM AND INNOVATION

The construction industry has long been the subject of a reform agenda (Green 2011; Smiley et al 2014 – both able to provide a much more expansive consideration of this phenomenon). In the UK, reports upon reports – such as Latham (*Constructing the Team*) in 1994, to Egan (*Rethinking Construction*) in 1998, to Wolstenhome (*Never Waste a Good Crisis*) in 2009, and most recently the Farmer (*Modernise or Die*) review of 2016 – have established an almost constant discourse of change, improvement and reform. Values of reduced time, lower costs and increased speed dominate (Smiley et al 2014), constructing an industry that in its current incarnation simply isn't good enough. Indeed, the UK Government's own Construction 2025 Strategy (HM Government 2013, published under the previous coalition administration that are no longer in power) firmly aligns to this discourse of change and reform, making demands that UK construction become 'Smart' and 'technologically advanced' (ibid 2013: 6), as well as improve on project delivery and costs by 50% and 33% respectively by 2025 (ibid 2013:7).

Yet concerns around poor productivity in the construction industry are not just a UK phenomenon (Farmer 2016). The World Economic Forum (2018:7) states that internationally construction operations 'still use primarily manual methods, offer traditional products and services and operate according to established practices and business models,' and so 'productivity has lagged as a result'. The industry is also not delivering on the global stage, and in many countries construction productivity

improvements have been 'meagre' over recent decades, including a 20% decline in construction labour productivity since 1964 in the US (World Economic Forum 2016).

Debates about productivity, improvement and industry reform are therefore nothing new, and the discourse of reform does not stop with critique of current work practices and sub-benchmark outputs. Another complementary discourse also permeates the industry; the discourse of innovation (Orstavik et al 2015; Dainty et al 2017). Innovation is positioned as both necessary and able to solve the industry's problems. As Farmer (2016:13) also stated in his scathing critique of contemporary UK construction industry operations: 'Other industries have harnessed wholesale process improvement by embracing and commercialising the role of technology and have effectively reinvented themselves by driving a paradigm shift in their end-to-end delivery.' For Farmer, innovation through technology is the solution to the UK construction industry's ills, and it is simply lagging behind due to a lack of implementation and adoption. Yet innovation in construction is arguably much more complex that this, and industry context is all important. Harty (2005) suggested five features of the construction industry that have significant bearing on the adoption of innovations in practice: the need for collaboration, its project-based nature, the modes of communication and information transfer, inter-organisational operations, and the way power is distributed in practice. Innovation in construction is therefore also highly complex, as complex as the industry and its established ways of working are themselves. To draw on the success of innovation in other industries as evidence of guaranteed success in construction is therefore problematic and can actually further 'complicate the adoption of new tools and processes' in practice (ibid 2005:513).

CONSTRUCTION 4.0 IRL

It is within this industry context, where the discourses of reform and innovation dominate, that Construction 4.0 has unsurprisingly found a most welcoming home. Just as BIM, which can now be seen as a pioneering step in this technological revolution, was heralded as the catalyst to 'revolutionise construction practice, through intelligence, efficiency and integrated project delivery…' (Dainty et al 2017:697), the same technocratic optimism and discourse of revolutionary progress now surrounds Construction 4.0 and it has become the panacea for positive change.

For example, Construction 4.0 has recently seen the use of robots for bricklaying (Quirke 2018), the development of autonomous geotechnical plant and machinery controlled by Artificial Intelligence (AI) rather than human drivers (Construction Manager 2018), and the use of technologically-enabled glasses for Augmented or Virtual Reality (Piroozfar et al 2018). Robots are now acquiring the basic low-level motor skills that have impeded them so far at an extraordinary rate, such as the ability to cross uneven ground for example (Brynjolfsson and McAfee 2014), something essential for their effective operation within a construction site space. Additive manufacturing (3D printing) is changing the production of construction materials and components, whilst drones are able to survey, set-out and even perform light lifting operations (Gammon 2017). The use of AI, AV, VR, the Internet of Things (IoT) and Digital Twins has further enhanced the potential for BIM models to be used for construction planning and co-ordination, with real-time data processing and adaptive machine-learning able to optimise construction activities (FIEC 2017) and so even take on the role of 'construction management' itself.

However, such developments and technological innovations are still relatively piecemeal, each addressing or providing a technological solution to specific problematic aspects of industry practice. They are arguably seen much more in press-releases, industry magazines and through social media than they are on any construction site. Indeed, despite its relatively long history within the industry, BIM has yet to make the inroads desired or prophesised. In spite of the UK government mandate that projects '…will require fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) as a minimum by 2016' (HM Government 2011:14) this target was not achieved. Instead *Building*'s 2018 survey of UK BIM-in-Use (Champ 2018) showed that although 73% are using BIM in some form, only 48% are achieving Level 2 (rather than 3D as per the government's target) and this is mainly for clash detection and collaborative design, as well as impressing clients and so being able to earn higher design fees. The promise has certainly not been realised in practice, and BIM has arguably become a sophisticated document control system rather than the catalyst for revolution.

Yet the speed of change is accelerating. Technological innovations are becoming more frequent and new developments are publicised on a regular basis. IR4 is occurring at a pace described as 'exponential' by Brynjolfsson and McAfee (2014), and although the construction industry has lagged behind, it has recently been suggested that Construction 4.0 is now more persistently 'seeping into the … industry' (World Economic Forum 2018:8). It would appear that the solutions to many long-term industry 'problems' are now finally arriving, and when set against a backdrop of ongoing improvement agendas and the inevitable desire for increased profit within our contemporary neoliberal economy, solutions with the capacity to improve production whilst reducing costs couldn't be more welcome. Indeed, change is not only desired, but also now inevitable.

TECHNOLOGICAL PROCESS AND TECHNIQUE: JUST BECAUSE WE CAN…

However, technology itself is not neutral (Ellul 1954). Before we embrace Construction 4.0 as the saviour of the built environment without question, we should perhaps pause and reflect on the unacknowledged autonomy it has been granted within our industry, the possibility for both intended and unintended consequences to emerge from its implementation, and also the potential for ethical conflicts with the EPOC Grand Challenges of social well-being and social value with regards to the work force.

In his seminal work, *The Technological Society* (1954), Jacques Ellul raises often overlooked questions regarding the nature of the links between technology, society and the place of people in this milieu. He demonstrates that, belying its ubiquity, there are fundamental aspects of the 'technological process', a process that has seen our lives become ever more reliant on technology and technical developments, that are rarely addressed and little understood. His insights provide us with the opportunity to unpack many of the unspoken assumptions that underpin the nature of significant developments, including Construction 4.0.

A typical response to the ever increasing use of technology is that it is 'meeting the needs of society' by, for instance, allowing it to communicate better, live longer. From Construction 4.0 perspectives, this need is clearly articulated through industry

reform rhetoric adopt which calls for more productive, efficient and cost effective ways of working (e.g. Farmer 2016 etc.) Yet by only focusing on the 'practical' uses of technology and its consequences, the underlying process of this development has gone largely ignored. Technology, states Ellul, needs to be understood as something far more than simply a means by which (through innovation, invention and improved organisation) the needs of society are met more effectively. Instead technology should be viewed as part of a wider (all-encompassing) process of *technique,* defined by Ellul as:

> *The totality of methods rationally arrived at and having absolute efficiency (for a given stage of development) in every field of human activity.* (Ellul 1954:xxv)

Viewed in this way, technique is a process that both forms (and now frames) our world; it is our environment. It is the space in which industry, economics, politics and people are now situated, and our activities are now defined by the use of technique, which includes technologies such as mass media and social media. The example Ellul gives is that it is no longer possible to carry out politics as we currently understand it without such technologies, but our understanding of what the political *is* and how it should be *done* has also been profoundly shaped by its use of technique (ibid 1954:395). Within the construction industry, technique can easily be identified within the phenomenon of Corporate Social Responsibility. In this context, technique shapes and structures the practices that enable and provide content for websites, tweets and other social media technologies that forms an organisational brands and profiles (Sherratt 2017a; 2017b). Essentially the medium dictates the message (McLuhan and Fiore 1967) and so directs organisational activities but also our expectations of them: this is how we now 'do' CSR in construction, despite the potential for misdirection of efforts towards the visual and photogenic as required by technique, rather than more worthwhile, but perhaps less glamourous, activities (Sherratt 2017b).

Ellul also highlights the autonomous nature of this process; given the rational and objective methods that are its driving force, technique lies beyond moral judgement or questioning. It therefore takes on a paradoxical nature as rather than meeting the needs of society, it instead *compels* society to perpetually adapt (whether it wants to or not) in order to meet the dictates that technique imposes upon it. Examples of this theory in practice abound, indeed it was observed at the outset of technique's triumph as Britain commenced upon its first industrial revolution (IR1 as it were) that 'Writers… beg[a]n to catalogue the social and human costs resulting from the systematic application of science and technology to the production of life's necessities and wants. Populations were dislocated, communities and neighbourhoods destroyed, local cultures undermined in order to prepare conditions congenial to modern industry.' (Wolin 2004 [2016]:400). This same process of people adapting (willingly or not) to the dictates of technique is also evident in recent developments in digital and social technologies: 'Individual web pages as they first appeared in the early 1990s had the flavour of personhood. MySpace preserved some of that flavour, though a process of regularized formatting had begun. Facebook went further, organizing people into multiple-choice identities [this 'standardisation' of format greatly facilitating their ability generate profits by selling the data gathered in this way.]… If a church or government were doing these things, it would feel

authoritarian, but when technologists are the culprits, [they] seem hip. (Lanier 2011:48)

Construction 4.0 therefore is not neutral, and is reshaping our expectations and understandings of what the construction industry is and how it should work. By embracing Construction 4.0 we are also inevitably embracing technique, and through technique any challenge to the autonomy of Construction 4.0 can be readily dismissed. Arguments against its implementation cannot be framed without those asking them being seen as 'Luddites' – indeed, as Construction 4.0 is comprised of rational and efficient processes that find excellent fit with our contemporary industrial problems, why is challenge even necessary?

SO WHERE IS THE CONSTRUCTION WORKER IN CONSTRUCTION 4.0?

Yet in our eager adoption of technologies to bring innovation and improvement to our industry, we are also allowing Construction 4.0 full autonomy, and as such the role of humanity is significantly reduced. Technique is by both nature and essence amoral, so what of ethics and social responsibility? Indeed, our industry does much more for our society that just create the spaces in which people live, work and play – it also employs vast numbers of workers worldwide, providing their income and support from activities that in return provide pleasure in their tangibility, collegiality and creativity, as well as the use of craft skills and ability. This is where the connection to the EPOC Grand Challenges of social well-being and social value emerges, and certain questions come to the fore: For example, is Construction 4.0 creating a world people want? Who sets the terms of the debate? Who directs its development? Whose needs does it serve? Who benefits from this process and who loses out? What is the purpose of this development? What role does (or should) humanity play in this process? These are questions we should (as noble academics of construction and engineering management research – see Sherratt 2017c) be asking, and here we look to the latter – and place the construction worker front and centre.

As the increased use of technology frequently reduces the need for human workers, it has been stated that 'there's never been a worse time to be a worker with only 'ordinary' skills' (Brynjolfsson and McAfee 2014:11). Although craft skills are seen as specialist when considered alongside general operative work on construction sites, when your skills are bricklaying, and a robot can now do that, your skill-set has unfortunately become 'ordinary', and you have become replaceable by default. Although for now workers are still included as recipients of the benefits that Construction 4.0 can bring, for example exoskeletons have been developed that are able to give humans super-human powers for manual handling, use of plant and other repetitive physical operations on construction sites (Gammon 2017), different questions may need to be asked when the robot no longer requires the body inside it.

Yet to focus on like-for-like replacement of workers for robots would be a misdirection. Indeed, when the bigger picture is considered, construction workers' future starts to look even more doubtful. To date, Construction 4.0 has seen myriad developments in a variety of technological areas, however such incremental innovation is still in piecemeal form. Effective 'recombinant innovation' (Brynjolfsson and McAfee 2014), where the most appropriate technologies for design, manufacture, assembly, construction and operation are combined will result in a holistically new approach to construction practice. A fundamental restructuring of

how we build and construct, grounded in BIM and digital twin modelling, is creating a future where construction work will occur with very different types of human involvement, something already being realised in industry rhetoric and discourse.

Indeed, the UK, and arguably the global construction industry, has long ignored the people who actually do the manual construction work: you will not find the names of the navvies who laboured and died to bring railways to the UK carved into the walls of the Institution of Civil Engineer's (ICE) prestigious headquarters, whilst those of their chief engineers are writ large. Traditional trades and the '…skills of building workers are devalued' (Ness 2009:652), such jobs even described as 'dirty and dangerous' by the World Economic Forum (2018:20). Such derogation continues with consideration of the industry's problems, when they note that construction operations:

> *'still use primarily manual methods, offer traditional products and services and operate according to established practices and business models. Productivity has lagged as a result.'* (ibid 2018:7)

Here 'manual' and 'traditional' activities are positioned as the 'reason' for poor productivity: the role of the worker has entered the discourse but not in any positive sense, and they are actually suggested to be something we should get rid of if we want to see improvements in productivity.

So who are the future workers of our industry? Currently the discourse of Construction 4.0 builds on that which presents the industry as a professional, management, white-collar space (Ness 2009), adding 'high-tech' aspects and enhanced engineering, creative and design skills (Brynjolfsson and McAfee 2014:135). Skills such as AI, data analysis and programming, robotics, modular design and engineering, as well as lean process skills and logistics specialists (World Economic Forum 2018) as all added to the list of requirement for the construction workers of the future, but again this conforms all too readily to the notion of the 'invisible construction worker' on the site. Despite promoting such Construction 4.0 skills as being necessary 'transformation imperatives', the World Economic Forum (2018:19) they have illustrated the need to 'attract new talent and build required skills' with an icon of a person – but that person is wearing a tie, not a hard hat (and let's not even mention gender here!). The future workers of Construction 4.0 are seen as able to innovate and have 'bigger ideas' (Scoones 2018), and to challenge and reform construction in ways we can't yet even imagine – but they do not lay bricks, stand in the cold, get muddy, or as Ness put it 'scratch [their] nail varnish' (2009:649). Indeed, trade workers should perhaps not be worried that they will be replaced by robots out on site, but rather be more concerned that the way construction production processes occur in the future will not require their input at all (Brynjolfsson and McAfee 2014:138).

Whilst the introduction of new technologies inevitably necessitates 'changing skills in the workforce' (FIEC 2017) and demands 'new competencies and skills from the workers' (Dalenogare et al 2018:385) for some construction workers this may not be a simple solution to their employment. Many trade workers ended up in construction because they struggled with the educational processes that would lead to many of these new roles. Many also enjoy the physical nature of the work; the fact that at the end of the day you have moved, stretched, put effort and even sweat into

the creation of something real, rather than sat behind a computer or machine all day with nothing tangible to show for it. In fact such skill-biased technical change can also be linked to the 'digital divide', and the skills to use ICTs and technologies are not distributed equally within society. Disparities often align to socioeconomic status and education (Epstein et al 2011) in eerily similar ways to the existing alignment of professional and trade skills found within the construction industry.

CONCLUDING THOUGHTS

Some large construction organisations, such as Gammon, have challenged this head on, stating that: 'the advantages far outweigh these concerns' (2017:16). They rightly note the global shortage of workers in the industry, its' ageing workforce, and the attractiveness of Construction 4.0 to young people considering entering the industry, and that '…for all these reasons, the integration of robotics, virtual reality and other automated technologies is clearly the way of the future' (2017:16). However, we should also be mindful of the role of technique in what appears to be the most serendipitous of revolutions for a struggling construction industry. We should be mindful of how technology is not only bringing change, but also shaping our expectations of change, and doing so with autonomy and amorally. For a discipline where industry engagement is key, it is all too easy to fall into the trap of simply accepting the dominant discourses of 'progress' and 'production' and 'growth' as societal norms, and simply aligning our research to fit (Sherratt 2017c)

Yet our role as academics is arguably to be more thoughtful than this, to be much more critical (Chomsky 1967), to look beyond such unspoken assumptions and ensure they are challenged where appropriate, or at the very least even acknowledged. We therefore hope that those researching Construction 4.0, innovation and production within our industry remain mindful of the EPOC Grand Challenges, specifically the social well-being and social value we bring to the world. We champion the emergence of a critical voice to supplement the technocratic optimism that currently dominates our industry and our current research agendas around Construction 4.0, and therefore also hope to ensure the support and recognition of those who actually construction and build our world.

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