BOOK REVIEW

Work and Technological Change Stephen Barley (2020) 176pp., £28 hardback, Oxford University Press, Oxford, ISBN 9780198795209

The book

Technology (and its various implications for work, the economy and capitalism) is a subject that has fascinated and engaged a wide range of scholars through the years. Some have been engaged for a very long time, while others have only recently arrived to analyse the particular impacts of new technologies, such as artificial intelligence. Stephen R. Barley has been around for some time and provides much needed perspective and context to these debates in a rather short (160 pages) new book, aptly titled *Work and Technological Change*.

The book is based on three essays Barley wrote as he was preparing his Clarendon lectures, delivered at Oxford University in 2016, and a fourth written later on. Each essay is a chapter, leading to a book in which each chapter is self-contained, allowing the reader to select only parts or to choose their own preferred order. The flip-side is that there is a slight feeling of the book being an edited volume with a certain lack of continuity, though this does not significantly detract from the overall impression. The third and fourth chapters are written with co-authors (Matthew I. Beane and Diane E. Bailey).

Work and Technological Change is a well-written, accessible, interesting and important book. It tackles some key contemporary issues and does a very good job of pulling the reader into a long line of established scholarship on both work and the nature of technological change. This is no small feat. Writers of all stripes and disciplines these days produce a dizzying volume of opinions on how artificial intelligence (AI) and other new technologies change everything – or not much at all. If more people read this short book, these debates will be much improved. The theoretical foundation Barley presents is both useful and convincing.

The Rorschach

Let us take a step back and survey the landscape in which this book exists. One intriguing point about the topic of technology, work and the production system is that it gives rise to a range of radically different descriptions and explanations. The plurality of interpretations of the impact of technological change on work suggests that technological change – like many other phenomena – is something akin to a Rorschach (the psychological test in which subjects are asked to find meaning in ink blots). There are many potentially valid interpretations and each interpretation reveals a whole lot about the author's disciplinary background, theoretical frameworks and main concerns.

Before delving into the interpretation provided by Barley, I'll place him in the general landscape of recent contributions to the analysis of phenomena similar to those Barley analyses. One framework that has received a lot of attention in recent years is Shoshanna Zuboff's (2020) notion of surveillance capitalism. Zuboff details how the major technology companies strive to extract surplus value from the data they collect. They strive to create something akin to a behaviourist's nirvana where citizens, consumers *and* workers are both surveilled and controlled. Others, such as Carissa Véliz (2020), speak of a data economy based on Zuboff's surveillance capitalism, in which the company's main objective is to gather data, as those data are valuable and a form of power. Surveillance is a keyword for Zuboff, and Véliz focuses on the related concept of privacy. Yet

DOI:10.13169/prometheus.38.4.0410

others focus on platforms, and how they give rise to what is called 'platform capitalism' (Mills, 2020). These are just some of the many terms and concepts used to describe how new technologies currently influence and shape our societies.

Work and the economy are essential components of society, and Barley's work and these more general attempts to get a hold on how technology changes the economic structures, and our societies in general, are tightly related. Common to all of the endeavours described thus far is that they aim to examine how technology leads to structural social change. Technologies are considered integral parts of a socio-technical system in which it makes little sense to restrict our analyses to the isolated effects these technologies have on the myriad of different economic, social and other phenomena.

Barley provides us with a robust framework for conducting such deeper analyses; it is a framework that deserves attention beyond Barley's own discipline. Surveying the literature on the effects of new technologies, such as artificial intelligence (AI), Big Data and the Internet of Things (IoT), one finds that industry 4.0 (Lasi *et al.*, 2014) and the fourth industrial revolution – the 4IR – (Schwab, 2017) have become the go-to concepts for how much the economy is changing. Barley wants none of this; one of the most interesting aspects of his book is his critique of the notion that we are now in a fourth industrial revolution. This makes the book more than interesting because his critique is both solid and eye-opening, and whenever a concept as complex as industrial revolution is casually thrown around in both academia and the general discourse on technological change, it is worth making sure that it is sound.

Technological change and the name of our time's revolution

Before evaluating the strength of Barley's contribution, we should dive a bit deeper into his framework. Barley himself states that his work is rooted in industrial sociology (particularly the Chicago School sociologists of the 1940s and 1950s) and he mentions Everett C. Hughes, Howard Becker and Anselm Strauss as major academic heroes. This background does not just manifest itself in the specific theories and findings presented in the book, but also in a surprisingly explicit emphasis on method.

The book shifts from micro to meso to macro levels as Barley focuses on how tasks change, how organizations will change when technologies change, and how our societies change as a result. At one point, in order to avoid the determinism often found in macro level analyses, he 'ratchets the resolution down by moving away from technical infrastructures and broad changes to consider specific technologies in specific workplaces used by members of particular occupations at particular times and places' (p.25). It is worth noting that Barley's movements between these levels are successful in bringing forth a more nuanced understanding of all the levels, and that analyses of all levels are essential for understanding technological change.

Barley has a clear aversion to determinism; he emphasizes how the effects of technological change are exceedingly hard to foresee, and that the unintended and unexpected effects are often as, or more, important than the obvious and expected ones. He conducts his meso level analyses by focusing not on jobs, tasks and practices, but rather on roles and role relationships, because 'role relationships change social networks' and 'social networks are an organization's structure' (p.27). However, how we do things also matters, and only technological change that alters 'how people do things and how they interact with others' can have more than minor societal implications (p.63). He uses computerized medical imaging and online car sales as two cases studies. The notions of 'scripts' and 'encounters' are used in a dramaturgical approach to technological change; our role as researchers is to 'determine whether the presence of a technology has somehow reconfigured the scripts, the stage, the props, the moves that actors make, or the encounter's footing in ways that sustain an altered or different line of action' (p.35).

One of the aspects of Barley's book I most appreciate is the depth to which he pursues the effects of technology on society, social relations and individuals. This is exemplified in his early

reference to Pelto's *The Snowmobile Revolution: Technology and Social Change in the Arctic* (1987). Pelto examines how the introduction of snowmobiles changed the Skolt Lapp community drastically – socially, economically and ecologically. Pursuing technology's wider and indirect effects is essential for any analysis of the effect of technological change, and this is one of the major strengths of Barley's book. Simplistic analyses of technology's direct effects – first-order effects (Sproull *et al*., 1991) – could easily have led to the conclusion that snowmobiles simply improved the effectiveness of the Skolt's reindeer herding, and left it at that. These kinds of analyses abound, and an example is how some conclude that AI is conducive to reaching sustainable development goals (SDGs) just because isolated cases indicate such effects (Vinuesa *et al.*, 2020). This is what Barley calls an 'isolationist view of technology' (p.75). He dismisses the kind of research that jumps to conclusions about wider effects based on isolated use cases or prototypes. I have recently argued that understanding the true effects of AI on SDGs requires factoring in the indirect medium- and long-term effects of new technologies (Sætra, 2021). When writing that article, I started reading and reviewing Barley's book, and I was immediately struck by the usefulness of Barley's analyses and foundational framework. He refers to these indirect effects as second-order effects, 'sneaky', hard to foresee and often sociocultural (p.11). Barley was duly cited, and this is indicative of the high praise I am in the process of giving his book. The fact that I have already begun using it in much of my own work should serve as a testament to its value.

Barley makes the point that we must distinguish between substitutional and infrastructural change. The first entails change where new technology can replace humans or existing technology without important indirect effects on social, economic or educational conditions. Substitutional change occurs within the existing sociotechnical system. Infrastructural change, as the name implies, entails broader and deeper consequences. Substitutional change is most common, and Barley notes that our institutions readily handle such change all the time. However, when the technologies that constitute the core elements of our systems of production change, things *really* change. Examples of key infrastructural technologies are electric power and engines, which Barley mentions as drivers of the second industrial revolution (or technological revolution, as he uses these two terms interchangeably).

Infrastructural technologies are intimately tied to systems of production, and thus to the techniques and occupations related to the world of work. Furthermore, these technologies fashion change in the social sphere, related to community, family, demography and education. They lead to changes in the 'modes and means of production' and 'gradually alter the division of labour in society' (p.9). Distinguishing between the two forms of change is essential because it allows us to examine whether specific technologies can be said to form the basis of a new industrial revolution, and it generally allows us to determine the scope of changes resulting from a particular technology.

One fascinating aspect of the book is that Barley refuses to jump on the bandwagon that readily accepts that new smart technologies lead automatically to infrastructural change. The book provides an important corrective to much work recently published, providing a much broader framework for placing such technologies in a historical and social context. Only then can we determine if the evangelists of the fourth industrial revolution are indeed correct, or if many of the changes we are currently seeing are merely substitutional, or simply the continuation of previous technological change based on, for example, communication and information technology. Barley suggests that there is much hype surrounding new technologies, and his solid analyses and framework support this position. Distinguishing between the two types is, however, not easy. Infrastructural change will entail substitutional effects, leading some to miss their broader implications, while what is merely substitutional change is often overstated and argued to be infrastructural.

One of the main questions Barley attempts to answer is: how will the technological changes occurring today change our societies? Previous industrial revolutions have brought drastic changes to the core institutions of our societies and the productive system. What will happen when all aspects of our production systems can be augmented by, or performed by, machines? What are the consequences for key institutions, such as education, family and the government (p.23)? That is the main

question relating to understanding the consequences of the control revolution. Barley provides us with a set of tools to help make sense of technological change. One is the idea of technological stacks and substrates, which I found to be a very useful way of analysing technologies.

At the very outset of the book, Barley challenges the notion that our age will – or should – be characterized as the fourth industrial revolution. This notion, which he attributes to both scholars and Silicon Valley techno-evangelists, describes the impact of important technologies, such as AI, machine learning and eventually 'the fusion of the digital and the biological' (p.2). However – and this is Barley's main point – these developments do not constitute a distinct and new industrial revolution, but are a continuation of what he refers to as the 'control revolution'. The point Barley makes, which is both an important and intuitive one, is that for a revolution to take place, the changes must entail changes in infrastructural technology and in the 'social organization of a society's productive activity' (p.11).

Barley attacks a set of myths related to technological change. While I cannot do them justice here, I will briefly present some of them as they highlight the character and key assumptions of Barley's book. The first is that a technology, such as AI, can cause a revolution. This is far too simplistic, Barley argues, as there will always be a number of interconnected and separate technologies involved. He connects this to Schumpeter's idea of a swarming of innovation and Kondratieff's long waves (Kondratieff, 1935). While certain key technologies may play important roles in revolutions, identifying these technologies and their importance will often be possible only after the revolutions have taken place, Barley argues.

The second myth is 'the fallacy of materialistic determinism' (p.13). Once again, Barley objects to the idea that technologies, through a materialistic and deterministic account, can cause revolutions. This, he argues, is a view widely held by proponents of 4IR, that new technologies will definitely lead to certain changes, and allow us to do certain new things in certain new ways. While infrastructural technological change is a necessary condition for revolutions, it is not a sufficient condition, and this is where Barley leaves some much-needed space for human agency and the possibility that social and political activity can shape the implications of new technologies.

The third and final myth is the very notion of the term 'revolution'. It is a political concept, Barley argues, useful for describing 'a discrete disjuncture in technological, economic, and social history' (p.15). Technological change, and the swarming of innovation in particular phases of history, is evolutionary. Barley refers to Beniger (1986) and draws on Faunce (1965) as he gets to one of his main theses, that what we are now seeing is not a new revolution but rather a continuation of a control revolution which 'has been working itself out for at least 200 years' (p.15).

For full details, the reader will have to refer to the book, or Faunce (1965) and others, but the core of the idea of a control revolution is as follows. There are four components of a production system: power, conversion, transfer and control, and there has been a total of four periods of particular interest to Barley: (1) the handicraft era, (2) the first industrial revolution, (3) the second industrial revolution and (4) the control revolution (p.17).[1] The changes between periods have been characterised by one or several of the components changing from being performed by an animate to a mixed or inanimate source. Characteristic of the control revolution is that control 'or regulation of the quality or quantity of output' (Faunce, 1965) is now performed by inanimate sources, while humans performed the control function in previous eras. Barley cites Zuboff (1988) and Vallas (2001) as he emphasizes how production processes are now increasingly controlled by computers overseen by relatively few engineers, as opposed to being controlled directly by human operators, the *modus operandi* of previous periods.

Barley looks closely at new smart technologies, but he focuses far more on the fundamentals of technology itself, and technological change, than on the specifics of these technologies. He mentions Amazon and its sophisticated websites and robot warehouses, Google's algorithms for finding

[1]Faunce (1965) writes about *three* periods, or phases, namely (1) craft production, (2) mechanized production and (3) automated production.

and presenting information, big data and smart grids. He also mentions how 'Microsoft and other companies are even experimenting with making inanimate humans' (p.21) – bots, if you like. These discussions could benefit from more depth to support Barley's argument, which is the following:

> Although advocates of the Fourth Industrial Revolution suggest that it is a quantum change, such technologies are better understood as an evolutionary outgrowth of the control revolution rooted in digitization that began in earnest during the 1980s based on the improvements in semiconductors, microchips, sensors, and machine learning whose early prototypes were developed in the 1960s. Today, digital control technologies are, to used Schumpeter's term, 'swarming'. (p.20)

While I wholly sympathize with Barley's critique of the notion of a 4IR, it is tempting to question the framework that he proposes might take its place. The control revolution might hold explanatory power, but a weakness of this framework is that it seems to be based on a logic implying that we are currently at the end stage of technological development, as the changes throughout the periods have led us to a situation in which all the components of our production system are now performed by inanimate sources. One might then question whether this framework allows for further change, or if a refusal to acknowledge a phase after the control revolution stems from a certain weakness in Faunce's – and Barley's – theory.

A plurality of perspectives and methods

I will close by mentioning three aspects in which I found some room for improvement in Barley's book. Barley focuses on the nature of technology and how it can lead to changes in roles and role relations. He repeatedly objects to determinism, and states that we have a choice, that technology can, in other words, be controlled. As Collingridge (1980) argues, this can be exceedingly hard once the technologies are in place. He also insists that understanding the implications of new technologies – including smart technologies – requires that we understand 'the agendas held and actions taken by firms, technologists, users, policymakers, and other stakeholders' (p.69). So far, I fully agree, and my only quibble is that Barley rarely helps us with this, and that the book provides little insight into human agency and the means for individuals, groups and the government to intervene in and influence technological change.

A second questions relates to how Barley's approach, by focusing on tasks, roles and relationships, and a somewhat material approach to technologies through stacks and substrates, might underestimate the value of information and data. He mentions data in passing, but data about people are largely missing from the overall picture. This leads to a concern that the framework in question might lead to the conclusion that we are not experiencing a new industrial revolution because the framework omits some of the key features of the new technologies that are currently swarming. Data, and the analysis and use of data, are arguably key drivers of the change described by the writers Barley challenges.

A third concern of mine throughout the book is how dismissive Barley is of theoretical work. 'Theoretical propositions about outcomes', he claims, 'are largely irrelevant', and all findings must be 'empirically demonstrable' (p.63). Furthermore, he believes that, unless 'we produce not only more but better empirical studies, we are likely to stumble our way into a future that the majority of us may or may not want' (p.vii). As a theoretically inclined researcher myself, I believe that both theoretical and empirical work has value, and I struggled to reconcile the adamant and harsh passages about methodology with the far more open and inviting writing on technologies and technological change. Methodology is obviously of great importance for Barley, and at times it interjects itself where it is out of place. This is the case when he argues in some detail that semi-structured interviews are recommended for analysing technological stacks, and the benefits of fieldwork and ethnography. That may be, but methodological evangelism feels out of place in the presentation of his theoretical framework. Even so, I happen to find the theoretical framework

useful, while disagreeing with Barley's constant reminders that 'good empiricism' is what we really need (p.70). The fourth chapter – 'Managing the fears of studying technical work' – is a good example of how the book at times rides several quite different horses. It is a practical guide to field-work, it is almost completely devoid of theory of work and technological change, and while it might be of use for students intending to heed Barley's commands about what methods to employ, it is of less interest to others.

Conclusion

> The danger is that we mistake what commentators say may be already happening for the inevitable and, hence, delay exploration and debate about how to deal with the challenges we face and the choice we will need to make to adapt to a much-transformed society. (p.24)

In closing, I'd like to return to the positive aspects of Barley's book because these are most certainly the most prominent. Barley and his co-authors have managed to write a short book that covers a breath-taking range of topics. It does so in a clear and concise manner, accessible to non-experts and people like me, who are not too familiar with industrial sociology. This is no small feat. That the book does not do more is thus not in any way a condemnation, but rather an endorsement of the importance of the book, and how clearly it relates the analysis of technological change to some of our time's most pressing questions. The book is thoroughly recommended for anyone interested in work and technological change, and it will be useful for students and researchers alike.

References

Barley, S. (2020) *Work and Technological Change*, Oxford University Press, New York.

Beniger, J. (1986) *The Control Revolution: Technological and Economic Origins of the Information Society*, Harvard University Press, Boston.

Collingridge, D. (1980) *The Social Control of Technology*, Frances Pinter, London.

Faunce, W. (1965) 'Automation and the division of labor', *Social Problems,* 13, 2, pp.149–60.

Kondratieff, N. (1935) 'The long waves in economic life', *Review of Economic Statistics,* 17, pp.105–15.

Lasi, H., Fettke, P., Kemper, H.-G., Feld, T. and Hoffmann, M. (2014) 'Industry 4.0', *Business & Information Systems Engineering,* 6, 4, pp.239–42.

Mills, S. (2020) '#DeleteFacebook: from popular protest to a new model of platform capitalism?', *New Political Economy*, 26, 5, pp.851–68.

Pelto, P. (1987) *The Snowmobile Revolution: Technology and Social Change in the Arctic*, Waveland Press, Long Grove IL.

Sætra, H. (2021) 'AI in context and the sustainable development goals: factoring in the unsustainability of the sociotechnical system', *Sustainability,* 13, 4, paper 1738.

Schwab, K. (2017) *The Fourth Industrial Revolution*, World Economic Forum, Geneva.

Sproull, L., Kiesler, S. and Kiesler, S. (1991) *Connections: New Ways of Working in the Networked Organization*, MIT Press, Cambridge MA.

Vallas, S. (2001) 'Symbolic boundaries and the new division of labor: engineers, workers and the restructuring of factory life', *Research in Social Stratification and Mobility,* 18, pp.3–37.

Véliz, C. (2020) *Privacy Is Power*, Bantam Press, London.

Vinuesa, R., Azizpour, H., Leite, I., Balaam, M., Dignum, V., Domisch, S. . . . Nerini, F. (2020) 'The role of artificial intelligence in achieving the sustainable development goals', *Nature Communications,* 11, 1, pp.1–10.

Zuboff, S. (1988) *In the Age of the Smart Machine*, Basic Books, New York.

Zuboff, S. (2020) *The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power*, PublicAffairs, New York.

Henrik Skaug Sætra
Faculty of Computer Science, Engineering and Economics,
Østfold University College, Norway
Henrik.satra@hiof.no