

# Blurring boundaries between humans and technology

Matthews, Adam

DOI:

[10.1080/2159676X.2020.1836508](https://doi.org/10.1080/2159676X.2020.1836508)

License:

Creative Commons: Attribution-NonCommercial-NoDerivs (CC BY-NC-ND)

*Document Version*

Peer reviewed version

*Citation for published version (Harvard):*

Matthews, A 2021, 'Blurring boundaries between humans and technology: postdigital, postphenomenology and actor-network theory in qualitative research', *Qualitative Research in Sport, Exercise and Health*, vol. 13, no. 1, pp. 26-40. <https://doi.org/10.1080/2159676X.2020.1836508>

[Link to publication on Research at Birmingham portal](#)

## **Publisher Rights Statement:**

This is an Accepted Manuscript version of the following article, accepted for publication in *Qualitative Research in Sport, Exercise and Health*. Adam Matthews (2021) Blurring boundaries between humans and technology: postdigital, postphenomenology and actor-network theory in qualitative research, *Qualitative Research in Sport, Exercise and Health*, 13:1, 26-40, DOI: 10.1080/2159676X.2020.1836508. It is deposited under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

## **General rights**

Unless a licence is specified above, all rights (including copyright and moral rights) in this document are retained by the authors and/or the copyright holders. The express permission of the copyright holder must be obtained for any use of this material other than for purposes permitted by law.

- Users may freely distribute the URL that is used to identify this publication.
- Users may download and/or print one copy of the publication from the University of Birmingham research portal for the purpose of private study or non-commercial research.
- User may use extracts from the document in line with the concept of 'fair dealing' under the Copyright, Designs and Patents Act 1988 (?)
- Users may not further distribute the material nor use it for the purposes of commercial gain.

Where a licence is displayed above, please note the terms and conditions of the licence govern your use of this document.

When citing, please reference the published version.

## **Take down policy**

While the University of Birmingham exercises care and attention in making items available there are rare occasions when an item has been uploaded in error or has been deemed to be commercially or otherwise sensitive.

If you believe that this is the case for this document, please contact [UBIRA@lists.bham.ac.uk](mailto:UBIRA@lists.bham.ac.uk) providing details and we will remove access to the work immediately and investigate.

Blurring boundaries between humans and technology: postdigital,  
postphenomenology and actor-network theory in qualitative research

Adam Matthews

*University of Birmingham*

[a.matthews.3@bham.ac.uk](mailto:a.matthews.3@bham.ac.uk)

# Blurring boundaries between humans and technology: postdigital, postphenomenology and actor-network theory in qualitative research

## **Abstract**

Digital technologies in sport, exercise and health along with every other aspect of human activity have the potential to change practices but also the very discourse and perception of an activity. As technology develops and devices become more 'smart', qualitative research requires theories and concepts with which to frame empirical study. Social constructivism at one end of a continuum says that society determines how new technologies are designed and used, in contrast, technological determinism states that technology develops along a single track of progress of development to determine the social. Both of these are explored and used as polar extremes to then blur boundaries with the theoretical positions of postdigital, postphenomenology and Actor-Network Theory (ANT). These perspectives critically look at the digital and the human and the mediation of experiences through technological artefacts and human agency in a network of humans, artefacts and culture. These perspectives are explored and contextualised through health and fitness tracking devices and presented as theoretical frameworks for qualitative research in sport, health and exercise.

## **Introduction**

This article explores theoretical perspectives for qualitative researchers interested in exploring the use of digital technologies in sport, exercise and health. Postdigital, postphenomenology and Actor-Network Theory (ANT) give the opportunity to blur boundaries between affording full agency to society or technological artefacts in the growing complexity of relationships between humans and digital technologies. Social constructivism and technological determinism are two polar extremes – the former, socially shapes technology and conversely, in the latter, technology shapes the social. Science and Technology Studies (STS) is an interdisciplinary field of scholars which intersect sociology, history, philosophy, anthropology and others which study the

process and outcomes of science and technology. STS is extremely diverse due to its interdisciplinary nature. Social constructivism within STS claims that social factors and forces result in new technological development in a non-linear manner whilst technological determinists state that technology develops independently of society along a single track with developments in the sciences which thus goes on to determine the character of society (Johnson and Wetmore 2008), Feenberg contrasts the two positions as:

“[Technological] Determinists usually argue that technology develops along a single track and in doing so shapes society. This view contrasts with a [social] constructivist position according to which there are multiple possible lines of development between which social forces choose.”

(Feenberg 2017, p. 77)

When posing the question of how digital technologies shape behaviours, societies and research, the ubiquitous and situated, embedded and habitual use of digital technologies in the everyday, adds complexity which doesn't neatly fit into small siloed and potentially reductive, deterministic boxes. STS is particularly useful as a field for qualitative research which has emerged to research the sociotechnical environment and has established itself as a discipline in its own right (Monberg 2005). This article reviews a range of perspectives for use in qualitative research in sport, exercise and health, embracing complexity and diversity of approaches as the digital, the material and the social become ever more entwined as boundaries are blurred between the human and the machine, and particularly when the moving body is concerned. Following this introduction is a brief look at the current technological landscape and a presentation of a case example to be used throughout. This is followed by an exploration of the two deterministic extremes

of social constructivism and technological determinism. These serve as extremes and polar opposites with which to explore the agency of individuals with three points of exploration – the postdigital, postphenomenology and ANT. These theoretical concepts are described and contextualised using the example of health and fitness tracking devices. The article concludes with a summary of the approaches covered to offer researchers in sport, exercise and health, theoretical and conceptual frameworks to use when considering human and technological relationships in qualitative research.

### ***Case Study Example - Health and Fitness Tracking***

Throughout, I will use the work of Esmonde (2020) ‘There’s only so much data you can handle in your life’: accommodating and resisting self-surveillance in women’s running and fitness tracking practices. I use this case study to add context and examples for the theoretical positions covered. As we can see from the title of this work, there is a balanced perspective in both accommodating and resisting different health and fitness data tracking practices. This balance of accommodating and resisting fits well with the conceptual polar extremes explored here of social constructivism and technological determinism along with the less binary postdigital, postphenomenology and ANT. Esmonde’s work which I will reference from now on throughout the paper as ‘Esmonde’s Runners’ takes Foucault’s biopower as a theoretical and conceptual framework with which to study the running practices of 10 women who run regularly using a self-tracking device, such as a watch or smartphone app.

The Foucauldian biopower perspective identifies the influence of discourse, power and knowledge in influencing individual behaviour. The practice of digital self-tracking can be conceptualised with biopower when underpinned by socially normative practices, influencing runners to conform to and regulate their running and health practices. For example, a common discourse that has become normative is that by

taking 10,000 digitally tracked steps per day, this equates to a healthy lifestyle. This data surveillance culture has resulted in what Haggerty and Ericsson (2000) have termed 'data doubles'. The data doubles which are created of individuals can then be scrutinized by organisations (consumer profiles, service delivery and target specific markets), employers, doctors and individuals themselves. Esmonde's Runners perceptions of running under these surveillant assemblages are examined under the practices of dataism, the Quantified Self (QS) movement and technologies of femininity<sup>1</sup>. In relation to QS movement, by using running apps, runners engage with digital tracking practices whereby they monitor the time, speed, location, distance of their runs and often share these in communities within apps (such as Strava). In relation to dataism, the universe is seen as a series of data flows in which human experience is seen as irrelevant, a dataist is only concerned with quantitative data and analysing the patterns of the data produced. (Harari 2016). In relation to femininity, these quantifiable data streams and patterns conform to and reinforce normative stereotypes of gender which women if they feel they do not live up to take up self-improvement projects such as self-tracking to attempt to align their data double with those which are held as quantifiably in the data as 'feminine beauty ideals'. Esmonde was interested in the agentic practices of self-tracking and found that individuals were not determined and dominated by tracking practices but describe resistance and selective affordances of tracking. Esmonde's Runners' strategies included labelling some forms of data tracking

---

<sup>1</sup> The quantified self movement is a global network of individuals who collect, analyse and share quantitative data about their activities and bodies collected through sensors and wearable technologies. Much of the marketing, social discourse and design of devices and apps used by the movement is particularly constructed around gendered ways of using such technologies to achieve a particular gendered ideal.

as excessive, choosing not to track every day, acknowledging that they cannot be perfect and valuing feeling over data. The final strategy of feeling over data contrasts the concept of dataism described above. The study (Esmonde 2020) does comment however that this particular group of runners were happy with the amount they exercised, and many have always maintained a healthy weight with little worry for diet and calorie control. Others may not be in such a position of control. Using this case study example of health and fitness tracking practices and devices, I will contextualise the theoretical positions of social constructivism, technological determinism, postdigital, postphenomenology and ANT throughout with Esmonde's Runners.

### **The development of digital technologies in sport, exercise and health**

The near future of technological development has been termed 'the fourth industrial revolution' or 'industry 4.0' (Schwab 2016) and 'Life 3.0' (Tegmark 2018). A key feature of future digital technological development is the 'cyber physical system' which blurs boundaries between the digital, the physical and the human. Material everyday objects are becoming 'smart' whereby they collect data and use algorithms, connecting to other data sources to advise on human action or to act independently, we are moving into a period whereby living with 'acting' technologies is central to human life. Physical artefacts are becoming connected to the internet, for example, health and fitness trackers used by Esmonde's Runners but also artefacts as diverse as home entertainment systems, fridges and cars, this has been termed the 'internet of things'. As figure 1.0 shows the move into industry 4.0 connects material 'things' to the internet.

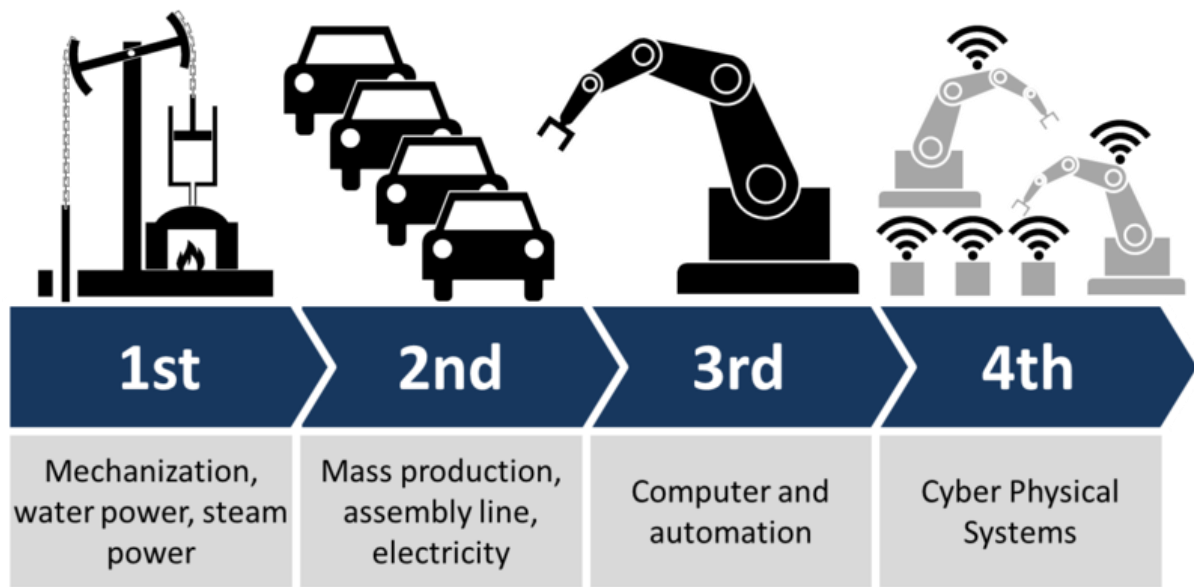


Figure 1.0 – Illustration of Industry 4.0

Creative Commons Licence

[https://commons.wikimedia.org/wiki/File:Industry\\_4.0.png](https://commons.wikimedia.org/wiki/File:Industry_4.0.png)

In sport, exercise and health, these technology developments have recently been seen through the growth in access and use of wearable trackers (e.g. Fitbits), the use and adoption of apps (e.g. Strava) and social media as a source of health-related information, alongside the growth in virtual and augmented environments that are challenging the conceptualization of sport and games. The data collection of wearable trackers and the use of this data has many opportunities but there are growing concerns over data privacy and surveillance practices. These developments in technology, widespread use and their influences require researchers to analyse the design, impact, affordance and use of such technologies. Two key questions for which scholars in the field of STS have grappled with throughout all of the 'ages' of technological revolutions and development, are:



- Will individuals and groups design and use technologies with an agency that allows for self-determination?
- Will technology determine, and control societies?

Theoretical and conceptual perspectives are needed, alongside empirical data to conduct qualitative research in response to these developments.

Within sport, exercise and health, digital technologies are playing a significant part in shaping behaviours and practices. New technologies can collect and analyse huge amounts of data, learn from this data and make recommendations for change (Novatchkov and Baca 2013; Bartlett 2004). Methods and analogies of software development have been co-opted to 'debug' the self and think of bodies and minds as our 'own computers' which can be fixed and debugged without the need for health professionals (Ajana 2017). As AI develops further and more data is collected these decisions could be outsourced to the app or platform in question in the sense that intelligence is becoming artificial. Lupton and Jutel (2015) suggested that 'It's like having a physician in your pocket!' in analysing the sociology of digitised diagnosis mediated by apps and the effects of doctor-patient relationship, medical authority and data surveillance. Data can be analysed at the individual level but also aggregated across populations (such as workforces as well as nations). This all falls under the discourse of self-optimisation which, it could be argued has a neoliberal, individualised aspect - if one does not take responsibility for their own self-improvement they are deemed as irresponsible. Platforms which people share their data with, hand over this data as payment for using such services, these sociotechnical services have been termed platform capitalism (Srnicek and De Sutter 2016).

This ability to collect quantitative data on everything from steps, heart rate, calories consumed, and much more has resulted in the QS movement in which researchers have critically analysed the impact of collecting data in sport, exercise and health and beyond with regard to the individual and the practice of ‘life tracking’ (Lupton 2016). The relationship between the technological artefact, the data produced and the social context all form complex assemblages. Two opposing discourses have emerged which can be described as technologies being part of the social in design, implementation and ‘use’. This contrasts with a deterministic discourse which is led by technological development to determine behaviour, potentially resulting in control and surveillance. These two discourses I will describe using social constructivism and technological determinism before exploring some of the middle ground through the postdigital, postphenomenology and ANT.

### **Deterministic positions – the social and the technological**

In popular discourse the argument which exemplifies our two deterministic positions of social constructivism and technological determinism is that of pro and anti gun crime groups with the common parlance of ‘guns don’t kill people, people do’ (Slack and Wise 2005). The gun makes the killing possible but the trigger is pulled by an individual, Slack and Wise term the former as technology as a cause (technological determinism) and the latter technology as an effect (social constructivism). With respect to wearable self-tracking technologies, we can use technology as a cause in being able to track myriad data points of the body and technology as an effect in that ‘users’ decide what and how to track. The latter then could use a humanistic strap line in countering common marketing discourse with ‘apps and devices don’t get fit – people do’. These two divides are common in everyday discourse around technology which can be

similarly divided by perspectives of dystopian pessimism and utopian optimism. These binary discourses have entered public discourse with technological development resulting in utopian liberation or dystopian take over by the machine as articulated by boyd and Crawford:

“Will large-scale search data help us create better tools, services, and public goods? Or will it usher in a new wave of privacy incursions and invasive marketing? Will data analytics help us understand online communities and political movements? Or will it be used to track protesters and suppress speech? Will it transform how we study human communication and culture, or narrow the palette of research options and alter what ‘research’ means? Given the rise of Big Data as a socio-technical phenomenon, we argue that it is necessary to critically interrogate its assumptions and biases.” (boyd and Crawford 2012, p. 662)

Such optimism and pessimism was reviewed by Casey et al (2017) with regard to the relationship between pedagogy, technology and education in health and physical education. Casey et al review recent pessimism in that digital technologies could increase performativity measures (e.g. a standard set of behaviours to be replicated in everyone), standardization (e.g. removal of teachers subjective ability), data-led surveillance (e.g. data is used to control behaviour rather than a gift to aid learning) and commercial interests (e.g. pedagogical and educational values are replaced by profit). An optimistic response from Casey et al (2017) calls for new ways of thinking which offer critical and constructive

dialogue to imagine new futures and technologies shaped by learners and learning, teachers and teaching and knowledge in context.

These two extremes can be encapsulated by the polar opposites of social constructivism and technological determinism. The concept of social constructivism was brought about by the coming together of both science and social science disciplines. The social construction of artefacts was conceptualised by Pinch and Bijker (1984) as 'social group', 'interpretative flexibility', and 'closure mechanism'. They asked why some artefacts thrive and become everyday pieces of technology. Pinch and Bijker's (1984) social groups refer to institutions and organizations, small or large, formal or informal which influence the success of the artefact and how it is used, if it is used at all. For example, Esmonde's Runners as users of tracking devices influence which devices and apps are used. The group also used the technology in different ways, in that they 'accommodate' some practices and they also 'reject' others. With these different uses, we can see Pinch and Bijker's interpretative flexibility, interpretative and flexible in that individuals, influenced by social forces will use digital technologies in many different ways and not just those imagined by the designer or marketer. Following and in conjunction with social group and interpretative flexibility, closure mechanisms refer to the acceptance and reification of a technology in that technologies become accepted as a problem that has been solved and thus often re-enforced through advertising discourse and peers as a social group. The closure mechanism results in this becoming a habituated norm. These are not permanent however and these black boxes can be re-opened within the social group's interpretative flexibility. Esmonde's Runners may disrupt and open this closure mechanism in many ways, a new product may enter the market or a data breach could result in negative media attention resulting in influences from the social group to start the whole cycle again.

In a similar fashion Grint and Woolgar (1997) use the metaphor of technology as text to describe the design, development, production and marketing of an artefact. Technologies as texts are written and then 'read' by the user of that artefact, and like any text, they can be interpreted in many different ways. This results in a feedback loop which causes a change to the artefact in a loop back to the design.

“Technology is created by engineers working alone or in groups, marketing people who make the world aware of new products and processes, and consumers who decide to buy or not to buy and who modify what they have bought in directions no engineer had imagined. Technology is thus shaped not only by societal structures and power relations, but also by the ingenuity and emotional commitment of individuals. Values, skills, and goals are formed in local cultures, and we can therefore understand technological creativity by linking it to historical and sociological stories.” (Bijker 1999, p. 3)

This passage from the introduction to *Of bicycles, bakelites, and bulbs: toward a theory of sociotechnical change* encapsulates the essence of social constructivism through case studies of the safety bicycle, Bakelite and fluorescent lighting. Social constructivism here is concerned with the people involved in the commissioning, designing and use of artefacts and the cultural, historical, sociological, political and legal aspects of technologies. This interpretative flexibility can be seen in the way that young people use and engage with wearable devices and apps. Goodyear and Armour (2018) report a variety of uses and approaches by young people when tracking health and fitness data. This complexity and context specific aspect of use (for example, young people in a specific context) is the space for qualitative

researchers to reveal just how these technologies are being used and what influences such use has as well as wider societal effects.

In the case of Esmonde's Runners we can ask how the devices and apps are designed, marketed and then used in context. Esmonde identified strategies used: selecting what to track, not tracking every day, acknowledgement that they can't be perfect and valuing feelings over data. As well as use, we may also trace the histories of the artefacts as commercial products which may take different routes or diverge in a fork like manner producing different artefacts for different social groups, for example many fitness trackers are aimed at certain groups such as elite athletes but may then be used by amateur sports clubs in different ways. On a larger scale we can look to the development of the Internet which grew out of complex developments in computer science and technically is a web of connected computers and has developed with many potentials. Two conceptions or affordances of the Internet can be described as a consumption model or a community model – consumption sees commodities bought and sold as products and services (for example apps such as MyFitness Pal as paid for in the traditional sense or in exchange for access to users' data) in a one to many model as producer and consumer, conversely the community model democratises each node of the web for access to information, global communication and shared commons (Matthews 2020). In a simpler more traditional sense we may see a chair used for sitting but a variety of uses maybe creatively conceived – a ladder to retrieve something at height, an artefact for hanging clothes, keeping a door open etc. We may only be part of the way in the development of personal trackers but a social constructivist perspective looks at how designs come to be and how those artefacts are used. Social constructivism of technology is a non-linear path shaped socially. In stark contrast to this approach is technological determinism whereby society is perceived to be shaped

and formed by linear technological progress, moving forward on a single track trajectory.

Technological determinism is the view that the properties of technology and material forces shape and determine social events (Sismondo 2010). Many technological determinists came to think that technology determines behaviour and society around the time of the industrial revolution and the rapidly expanding technologies that powered factories and mass production. Ellul (2011) and others in the mid 20<sup>th</sup> century were observing a rapid increase in technological development. Ellul (2011) saw technology as a driving force of everyday and occupational ways of doing things in the push for efficiency whereby any progressive answers to problems become technological rather than social. Similarly, Heidegger wrote in the 1950s in the essay, *The Question Concerning Technology* that

“Everywhere we remain unfree and chained to technology, whether we passionately affirm or deny it. But we are delivered over to it in the worst possible way when we regard it as something neutral; for this conception of it, to which today we particularly like to do homage, makes us utterly blind to the essence of technology.” (Heidegger 1977, p. 3)

Heidegger’s essay argues that technology is not a neutral instrument which we use but a way of understanding the world. Heidegger denies that technology is a human activity but develops beyond human control and that technology is a risk and dangerous with the potential to result in only seeing the world through efficient technological thinking.

Later work by Ellul (1990) talks of public reason and technological determinism in a similar way, terming the idea that people unquestionably accept technology as

progressive, problem-solving and advantageous even though it could go against values and ethics (Selwyn 2019). Ellul (1990) concluded that people are either “fascinated” or “diverted by technology”.

Philosophers and STS scholars have in the main rejected these extreme views of technology exclusively determining the social (Coeckelbergh 2017). Whilst intellectually, the notion of technological determinism has been dismissed and refuted, the idea of technology having inherent attributes with cause and effect is alive and well in popular discourse. For example, common discourse often states: the internet ‘shrinks’ the world, text messaging has a negative effect on vocabulary, video games cause violence and self-tracking in sport and exercise results in obsessive and addictive behaviour, body dissatisfaction, negative mood states and extreme weight loss (Selwyn 2012; Goodyear et al 2019). *Technological Determinism Is Dead; Long Live Technological Determinism* (Wyatt 2007) characterises the potential return of technological determinism as a viable concept to describe technological development determining the social. Wyatt (2007) in this work and others such as Smith and Marx (1994) argue that the idea of technology driving the social has culturally come to be seen as ‘common sense’ mainstream discourse, as described above. Technology and new inventions are seen as efficient and progressive forces that we all adapt to and use. Wyatt (2007) highlights this issue of individual responsibility, whereby blaming technology may seem to absolve individuals of their actions. Wyatt (2007) identifies four types of technological determinism – justificatory, descriptive, methodological and normative. Justificatory technological determinism is characterised by justifying an action based on a technological device, for example, only consuming a certain number of calories or justifying a run to complete a certain number of running miles in a week and/or not taking part in other aspects of social life because of this. Descriptive



technological determinism describes a situation and attributes cause and effect to the technology, i.e. fitness tracking devices result in greater fitness and weight loss or they control everything that an individual does with potential adverse effects.

Methodological technological determinism seeks to look at technologies available to society and that technology in use determines society – if there is a technology there, it will be used by individuals – runners run more if they have the tracking technology?

Normative technological determinism is characterised by tracking becoming an everyday norm, characterised by technological rationality which is not even questioned and decoupled from any political or individual accountability – runners habitually and normatively track without a second thought.

Deterministic positions can be compelling in that they simplify and essentialise a technology. In the case of fitness tracking, they could be described deterministically and reductively as the *cause* of anxiety or the *enhancement and improvement* of an individual's health (Goodyear et al 2019). Having explored two extremes of technology – the social construction and technologically determined - I now move on to explore some theoretical positions between these two points.

### **Blurring boundaries – postdigital, postphenomenology and ANT**

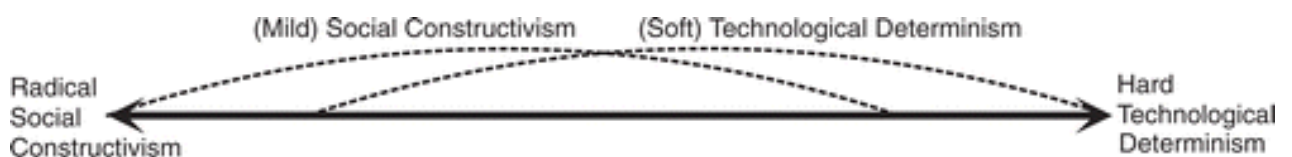


Figure 2: Taken from Dafoe (2015): “A continuum of scholarship, from social constructivism to technological determinism.” (1050)

Having explored the polar opposites of social constructivism and technological determinism above, figure 2 demonstrates these two opposites not as binaries but as a continuum. Along this continuum I will use postdigital, postphenomenology and ANT

which take into account both human and technological agency in the context of self-tracking. Dafoe (2015) describes this continuum as:

“The question should not be a dichotomous one of whether technological determinism is right or wrong, but a set of questions of degree, scope, and context: to what extent, in what ways, and under what scope conditions are particular kinds of technology more autonomous and powerful in shaping society? The complement of this framing also clarifies questions about human agency: to what extent, in what ways, and under what scope conditions are particular groups of people able to shape their sociotechnical systems?” (Dafoe, 2015, p. 1049)

The idea of a continuum of agency moves us away from committing to a binary determinism in which the social determines technology or symmetrically that technology determines the social. This was apparent in Esmonde’s Runners in that there isn’t a clear dualistic divide as the runners both accommodate some and resist other running and fitness tracking practices. Rather there is a complex relationship between the social and the technological in a variety of contexts. These positions now give us a starting point to explore some theoretical perspectives for a qualitative research toolbox in exploring the middle ground between social constructivism and technological determinism when researching digital technologies in sport, exercise and health.

### ***Postdigital***

Plotted along the midpoint of the continuum above is the postdigital (Jandrić 2018a) which looks to move beyond a digital divide of ‘online’ and ‘offline’ and thus is an important perspective to explore as part of this article which explores the blurring boundaries between the social and technological. The postdigital is a critical perspective allowing us to look at a range of phenomena without such techno-optimistic positions

that have entered into general discourse of the digital having an inherent, uncritical good. The postdigital has been characterised in several ways:

- We are now beyond digital, the digital revolution is over and now this technology is taken for granted
- The digital is something that has happened – not an innovation but something to be reconfigured
- The merging of old and new media into complex assemblages
- Rejecting the binary ‘digital revolution’ of being on/off
- Relationships between technology and human agency
- Relationships between technology and space

(developed from Jandrić 2018a; Taffel 2016).

The postdigital brings the digital into everyday interactions and acknowledges both its advantages, disadvantages and all points in between as well as interactions with the social and non-digital. The postdigital is positioned within every day practices to look beyond the novel and new and into the real effects and influence of digital technologies in use.

“Therefore, the postdigital is about dragging digitalisation and the digital—kicking and screaming—down from its discursive celestial, ethereal home and into the mud. It is about rubbing its nose in the complexities of everyday practice, such as managing a class of 7-year-olds working on tablets (half of them not charged and the other half with links to dubious sites); the realities of gender or racial bias of algorithms or how notions of imagined efficiency gains

brought about by ‘the digital’ impact on work-life balance in organisations.”

(Jandrić et al. 2018b, p. 4)

The postdigital perspective allows for us to be removed from thinking of the digital as something which is dropped into social realities to change and revolutionise. Moreover, the ubiquity of such digital technologies for the postdigital perspective is now seen as the everyday, embedded in everyday practices.

“The term ‘Postdigital’ is intended to acknowledge the current state of technology whilst rejecting the implied conceptual shift of the ‘digital revolution’ — a shift apparently as abrupt as the ‘on/off’, ‘zero/one’ logic of the machines now pervading our daily lives. New conceptual models are required to describe the continuity between art, computing, philosophy and science that avoid binarism, determinism or reductionism.” (Pepperell and Punt, 2000, p. 2)

Looking towards Esmonde’s Runners and their digital tracking devices, postdigital scholars shine a light upon digital devices and the data that they collect and the resulting impact upon social lives in the context of the embeddedness of devices and data. For example, for Esmonde’s runners the digital is used in everyday routines and by focusing on the digital technology, a run can potentially be turned into just a quantifiable act measured in data as bits and bytes. Just because a host of data points about our lives can be tracked, the postdigital raises questions of neutrality, positivism and uncritical good in the use and embeddedness of such technologies. The binary nature of digital technologies is quantitative, the postdigital perspectives warns of this discourse entering into social practices based on the technical architecture of the digital. Esmonde (2020) uses the concept of dataism in that quantifiable numbers are seen as

the ultimate measure of most aspects of life which create data doubles to be shared and to be proud of or hidden and in shame. Health and fitness tracking cannot be purely seen as a technological practice but a social one where discourse around body image and healthy practices are controlled by dominant discourses.

Lupton's (2016) work on the QS movement highlights the new digital and automated possibilities of tracking behaviours (Lupton 2016). The digital nature of this data collection contrasts with what may have previously been written down using pen and paper. Although a personal activity, users do hand over data as currency for services which can collated centrally to be compared. This quantifiable positivism can also be found in public health messaging whereby daily health and exercise guidance can be wrapped up in a series of numbers, for example, five portions of fruit and vegetables a day, 10, 000 steps and 30 minutes of exercise etc.

Qualitative research in sport, exercise and health can use the postdigital as a perspective to research qualitative experiences of the digital and the quantified in everyday practice and experience. The postdigital looks to bring this technology into real life and ask how it is part of everyday practices and politics and not to be seen as 'shiny and new' but how can it be reconfigured. Postphenomenology and ANT take us further into the agency and roles afforded to the material, digital and non-human artefacts.

### ***Postphenomenology***

Postphenomenology takes an 'empirical turn' in looking at material artefacts. Phenomenology is a vital epistemological methodology in the toolbox of qualitative researchers in sport, exercise, health and beyond, capturing the individual experience of the human lifeworld (Allen-Collinson 2009; Embree and Mohanty 1997). Broadly

speaking phenomenological approaches are concerned with individual's perception of the world, interpretation of symbols and text used by individuals and body and consciousness intertwined. The latter is an important strand for qualitative researchers in sport, exercise and health due to the essential mind and body connection (Clegg and Butryn 2012; Purser 2018). In the 1980s and 1990s philosophers of technology began to focus much more on objects themselves and the technological artefact, this began the empirical turn of philosophy of technology (Achterhuis 2001). Objects themselves were brought into the forefront of analysis, including the embodiment of technological artefacts as an extension of the body. This analysis also included their design and place in society (Coeckelbergh, 2020). New materialist approaches are looking beyond anthropocentric agency to non-human actors having an impact on the social (Fullagar 2017; Monforte 2018).

Critiques of phenomenology and more broadly the linguistic turn to discourse have identified the lack of materialism and the role of the artefact. The term, postphenomenology was introduced by philosopher Don Ihde (1995) in reaction to this critique that phenomenology didn't incorporate the material, in particular technology and the way it mediated between human perception and reality and the reciprocal human–technology interrelationship. Postphenomenology sits in between the extremes of social constructivism and technological determinism, building on classic philosophy of technology from Heidegger (1977) and rejecting the reification of technology as a monolithic deterministic, dystopian, grand narrative which controls humans and restricts agency. Ihde (1995) used examples of microscopes, telescopes and X-ray imaging as technologies which mediate relationships with the world and 'reality'. One could say here that technological artefacts have a voice. The voice is quite literal when an app

provides written and spoken feedback based on one's data double to motivate or feedback using algorithms. Ihde (2012) describes technological artefacts as having multistability in that their designs are not essentialised to be used as one thing:

“...a hammer may be a murder weapon, a paperweight, an art object, and so on; cell phones have been used as detonators and as devices to help victim hunters find people after earthquakes or may, as in the hacking incidents of summer 2011, be used to snoop, deceive, and even bring down politicians...” (Ihde 2012, p. 328)

Verbeek (2005) builds on and develops the concept of the postphenomenological empirical turn with his own mediation theory with the idea of artefacts having morality. Verbeek's (2005) work looks at human-technology relations and the design of artefacts and how these artefacts mediate morality and shape the human, and what we *do* (Coeckelbergh 2020). This contrasts with technological determinism but doesn't afford society full agency as would the social constructivist perspective. Artefacts from this perspective have morality as they have the potential to improve lives when mediating our actions with the world (Verbeek 2005). Aagaard (2017) sketches out postphenomenology opportunities in qualitative research, identifying opportunities to explore in-depth analysis of a technology and its typical use and critical comparison of multiple versions of the same technology. Ihde's (1990) postphenomenology states that technology mediates our experience through different relations: *embodiment*, *hermeneutic*, *alterity* and *background*. Embodiment relations with technology use examples such as communicating with someone through a telephone or viewing something through a microscope, consider a video analysis of a

golf swing or a runner's gait analysis. The individual in Ihde's (1990) *embodiment* relations is not necessarily concerned with the artefact but the artefact is mediating the experience. In the context of Esmonde's Runners, the *embodiment* of health and fitness trackers can be described as seeing an activity through the device in question – a run or eating something – embodiment of the tracker mediates this experience. *Hermeneutic* relations for health and fitness trackers can be described as seeing an activity, a run for example through the technological device, it is represented as numbers – distance, calories, pace etc. *Alterity* relations are the direct use of a machine, such as a cash machine, the design of the machine is important as the individual interacts directly with it. Evermore sophisticated 'virtual' experiences can take cyclists and runners in their home or gym to cycle a Tour De France route or run a marathon in any city in the world (Zwift 2020). In the case of Esmonde's Runners interacting with watches and smartphone apps and the way these work such as navigation and use of language mediates the experience. For example, text or talk by the device might use motivational words or speech, this discourse again mediates the experience. Finally, Ihde's (1990) *background* mediation almost go unnoticed or part of the everyday experience. Fitness trackers make background noises, for example a beep to start a run or when a kilometre has been completed. In an organised race situation these background beeps are created by the technological devices but go unnoticed. Heating or air conditioning systems are often described as background relations as the technology regulates temperature which goes unnoticed other than through a background hum or buzz. The presence of background technology can often only be noticed when it is not there, for example when using a tracking device and it fails to work or is forgotten, potentially affecting the runner's experience and mood.



### ***Actor-Network theory***

Actor-Network Theory (ANT) moves us further to the centre of a continuum from social constructivism to technological determinism, seeing humans, material objects, history, values and ideas (and many more) as social assemblages that impact on each as co-constructing actants in a network, constantly evolving and changing (Latour 2007). The important distinction between ANT and postphenomenology is the decentring of human agency over the material and the social. ANT radically involves not just the human and material divide but also includes abstract non-material and non-human such as culture and values. Material artefacts also have agency in the network and are in constant flux with varying degrees of influence for each node in the network. Esmonde (2019) describes the agency of humans and non-humans in a running scenario whereby the environment and the body move through different spaces (gyms, parks, etc) along with tracking devices and data giving feedback on pace, time and distance etc influenced by algorithms. In ANT terms, these are sociotechnical entanglements which cannot be separated into the individual, the environment, the device, the data. These are all ordered as constantly changing and evolving networks. Tracing networks of the social, material and human is a sociology of associations. Networks are made and come together in a complex and messy manner with the material and the social working together. Law (1992) gives the example of a university lecture theatre, the physical tables and chairs, along with the acceptance of the normalisation of the lecture as someone standing to a group of people, usually along with an electronic visual aid – this all makes up a network and doesn't put the human at the centre.

A clear challenge in practical use of ANT is how to carry out research in practice. A key element of ANT is the idea of black boxes and whether to open them and which ones to open. Callon (1984) looks at how networks are created and how they

are in constant flux. When stability is applied to an actor-network, Callon (1984) describes this as a 'black box'. Within ANT black boxes are used as a framework to observe inputs and outputs. The researcher here, knows and analyses the inputs and outputs but sees the black box as taken for granted or unknown. Opening these black boxes can reveal how this normalisation has come to be. A highly cited example is the camera (Latour 1987), you take a picture and a photograph is produced. The highly complex electronics and design decisions that came about to make the camera and the social acceptance of the artefact is a complex actor-network with actants vying for power and influence. Once this has settled down and normalised the black box is closed, researchers can open these boxes to understand how material objects come to be in the social.

Fenwick and Edwards (2010) use ANT to consider a range of scenarios in education and map assemblages in standardisation of education and how the most powerful actors dominate standards and ways of educating. Evermore sophisticated apps (such as Strava and MyFitness Pal) provide health and exercise advice and guidance based on collected data, qualitative researchers can explore the inputs and outputs but opening the black box can allow for analysis of the social and technical networks, which have produced the app (such as algorithms and code). A similar methodology is used by Phoenix (2010) to analyse photographs and graphics by analysing what is constructed, how it is constructed and the ways of seeing the images in both production and reception to form a genealogy of the artefact.

Tanggaard et al (2016) looked at creativity in the sport of handball by tracing the materiality of the ball itself. A creative approach was used to 'interview the ball'

through a series of interviews with the designers of the material object. Distributed creativity was termed to trace the development of the ball over 50 years, concluding that new developments have benefited attacking players. The ball, resin and playing surface all play an important part in the game and experience of players. This is then important when looking at the development process and decisions that are made within this process. ANT is a radical departure from more traditional qualitative approaches such as phenomenology to capture the individual's perception of their experience of a situation. Esmonde's Runners resisted the technological determinism of their tracking devices by emphasising that their tracking activities did not always dominate their activities. ANT says that the human is not at the centre here and equal agency should be afforded to the device and the culture of fitness and health tracking practices. A black box in this instance is the device itself and how it has come to be – the commercial reasons, the technology available to designers, the marketing approach, the use of the device in social groups – here we have many nodes in the network to analyse and trace. The task for the qualitative researcher is to identify black boxes and then to use methods which track these networked assemblages and the actions which result from these.

## **Conclusion**

This exploration of polar extremes of the social construction and technological determinism of digital technologies bridged with theoretical frameworks of the postdigital, postphenomenology and ANT offers theoretical and conceptual positions for qualitative research in sport, exercise and health involving digital technologies. New technologies are connecting physical things to the internet for data collection and using artificial intelligence to aggregate and analyse this data to advise and make decisions impacting upon society. I have taken extremes of social constructivism and technological determination as starting points and then blurred boundaries and crossed

these divides with the postdigital, postphenomenology and ANT. For qualitative researchers in sport, exercise and health this allows for the digital, the material and the social to be theorised holistically and not treating digital technologies as something siloed, rather they are embedded and part of our everyday practices. Among the many potential uses for such theory is the QS movement (Lupton 2016) in which I have taken a case example of Esmonde (2020) to contextualise and give examples of potential use of these frameworks when researching digital devices in sport, exercise and health. Here, digital technologies are capturing data of the individual from calorie counting to exercise and sporting performance. Taking health and fitness tracking devices and smartphone apps as an example we can blur boundaries of social determinism (full human agency and control) and technological determinism by using interpretative flexibility and multistability to see how the devices and data are used in practice and influence behaviour and experiences.

In common discourse, technologies are often heralded as utopian and dystopian in that that techno-optimism can solve a raft of societal issues through to technology controlling and infantilising society. The frameworks covered here add complexity and nuance as to how digital technologies are conceived, used and the effects they have on individuals and society. Esmonde's (2020) work highlights the agency of participants as they described how in control they are of their tracking and quantifying of exercise and calorie consumption. Using a phenomenological approach here, individual's perception of tracking practices is one of control and moderation.

Postdigital, postphenomonology and ANT are theoretical frameworks which specifically look to technologies and the objects used as well as human experience to

offer concepts for qualitative research. The postdigital offers perspectives which look at the digital as not something new but something which is an everyday part of our lives, it does not have an on/off switch and this critical aspect rejects the often common discourse of digital ‘solutions’ having an inherent good. The postdigital warns against the binary technical nature of the digital to be imposed upon the social quantitatively. Postphenomenology and its empirical turn is much more concerned with material objects and their use and how they mediate our experiences of the world – seeing a run, a meal and weight as a set of numbers on screen. Using ANT we can open black boxes to understand the culture that has enabled such digital technology to flourish, the design decisions made by companies and designers and a whole range of human and non-human assemblages in the network of actants. These approaches do not sit in their own siloed ‘toolboxes’, for example ANT and postdigital can work together to bring about thinking in a range of environments, for example, teaching and learning in higher education (Matthews 2019).

This article has not attempted to pit existing qualitative research paradigms as superior in ‘protectionist paradigmatic behaviour’ as described by Weed (2009). Rather, they offer different perspectives to be used and adapted to work alongside and complement existing qualitative methods in sport, exercise and health. The challenge is to frame particular questions in amongst the noise and messiness of the digital and the social and blurring boundaries and crossing divides, identifying, opening and closing black boxes in creative and non-monolithic ways. Postdigital, postphenomenology and ANT have many commonalities and cross over in approach. The postdigital in contrast with postphenomenology and ANT continues to develop and is the broadest of frameworks offering criticality and resistance to the ‘digital revolution’ and

quantification. Postphenomenology allows us to focus on the ‘thing’ – the smartphone app and running watch to analyse how the artefact mediates individual’s experiences in context. ANT goes further by decentring human agency in complex networks of artefacts and culture which co-construct actions.

The advantage of removing these binaries can also be a disadvantage and a criticism of such frameworks and philosophies. Drawing boundaries maybe needed to frame a question or focus on a ring-fenced environment. This has always been the challenge as well as the advantage of qualitative methods, and the knotty issues of complexity and messiness to analyse and form knowledge about rich human experiences of digital technologies in design, use and impact.

## References

- Achterhuis, Hans, ed. 2001. *American Philosophy of Technology: The Empirical Turn*. The Indiana Series in the Philosophy of Technology. Bloomington: Indiana University Press.
- Ajana, B 2017, Film Documentary: "Quantified Life" (2017).
- Bartlett, Roger. 2004. ‘Artificial Intelligence in Technique Analysis - Past, Present and Future’. *International Journal of Performance Analysis in Sport* 4 (2): 4–19. <https://doi.org/10.1080/24748668.2004.11868299>.
- Bijker, Wiebe E. 1999. *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*. 3. Aufl. Inside Technology. Cambridge: MIT Pr.
- boyd, danah, and Kate Crawford. 2012. ‘CRITICAL QUESTIONS FOR BIG DATA: Provocations for a Cultural, Technological, and Scholarly Phenomenon’. *Information, Communication & Society* 15 (5): 662–79. <https://doi.org/10.1080/1369118X.2012.678878>.

Callon, Michel. 1984. 'Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay'. *The Sociological Review* 32 (1\_suppl): 196–233. <https://doi.org/10.1111/j.1467-954X.1984.tb00113.x>.

Casey, Ashley, Victoria A. Goodyear, and Kathleen M. Armour. 2017. 'Rethinking the Relationship between Pedagogy, Technology and Learning in Health and Physical Education'. *Sport, Education and Society* 22 (2): 288–304. <https://doi.org/10.1080/13573322.2016.1226792>.

Clegg, Jennifer L., and Ted M. Butryn. 2012. 'An Existential Phenomenological Examination of Parkour and Freerunning'. *Qualitative Research in Sport, Exercise and Health* 4 (3): 320–40. <https://doi.org/10.1080/2159676X.2012.693527>.

Coeckelbergh, Mark. 2017. *Using Words and Things: Language and Philosophy of Technology*. Routledge Studies in Contemporary Philosophy 92. New York: Routledge, Taylor & Francis Group.

Coeckelbergh, Mark. 2020. *Introduction to Philosophy of Technology*. UK: Oxford University Press.

Dafoe, Allan. 2015. 'On Technological Determinism: A Typology, Scope Conditions, and a Mechanism'. *Science, Technology, & Human Values* 40 (6): 1047–76. <https://doi.org/10.1177/0162243915579283>.

Ellul, Jacques. 1990. *The Technological Bluff*. Grand Rapids, Mich: W.B. Eerdmans.

Ellul, Jacques. 2011. *The Technological Society: A Penetrating Analysis of Our Technical Civilization and of the Effect of an Increasingly Standardized Culture on the Future of Man*. New York, Knopf. A Vintage Book. New York, NY: Vintage books.

Esmonde, Katelyn. 2019. 'Training, Tracking, and Traversing: Digital Materiality and the Production of Bodies and/in Space in Runners' Fitness Tracking Practices'. *Leisure Studies* 38 (6): 804–17.

<https://doi.org/10.1080/02614367.2019.1661506>.

Esmonde, Katelyn. 2020. "'There's Only so Much Data You Can Handle in Your Life": Accommodating and Resisting Self-Surveillance in Women's Running and Fitness Tracking Practices'. *Qualitative Research in Sport, Exercise and Health* 12 (1): 76–90. <https://doi.org/10.1080/2159676X.2019.1617188>.

Feenberg, Andrew. 2017. *Technosystem: The Social Life of Reason*. Cambridge, Massachusetts: Harvard University Press.

Fenwick, Tara J., and Richard Edwards. 2010. *Actor-Network Theory in Education*. 1st ed. Milton Park, Abingdon, Oxon ; New York: Routledge.

Fullagar, Simone. 2017. 'Post-Qualitative Inquiry and the New Materialist Turn: Implications for Sport, Health and Physical Culture Research'. *Qualitative Research in Sport, Exercise and Health* 9 (2): 247–57.

<https://doi.org/10.1080/2159676X.2016.1273896>.

Goodyear, Victoria A., and Kathleen M. Armour. 2018. 'Young People's Perspectives on and Experiences of Health-Related Social Media, Apps, and Wearable Health Devices'. *Social Sciences* 7 (8): 137. <https://doi.org/10.3390/socsci7080137>.

Goodyear, Victoria A., Charlotte Kerner, and Mikael Quennerstedt. 2019. 'Young People's Uses of Wearable Healthy Lifestyle Technologies; Surveillance, Self-Surveillance and Resistance'. *Sport, Education and Society* 24 (3): 212–25.

<https://doi.org/10.1080/13573322.2017.1375907>.



- Grint, Keith, and Steve Woolgar. 1997. *The Machine at Work: Technology, Work, and Organization*. Cambridge, UK ; Malden, MA : Blackwell Publishers: Polity Press.
- Haggerty, Richard and Ericson, Kevin. 2000. 'The Surveillant Assemblage'. *British Journal of Sociology* 51 (4): 605–22.  
<https://doi.org/10.1080/00071310020015280>.
- Hall, G. 2013. 'Toward a Postdigital Humanities: Cultural Analytics and the Computational Turn to Data-Driven Scholarship'. *American Literature* 85 (4): 781–809. <https://doi.org/10.1215/00029831-2367337>.
- Harari, Yuval Noah. 2016. *Homo Deus: A Brief History of Tomorrow*. Vintage Popular Science. London: Harvill Secker.
- Heidegger, Martin. 1977. *The Question Concerning Technology, and Other Essays*. New York: Garland Pub.
- Ihde, Don. 1990. *Technology and the Lifeworld: From Garden to Earth*. The Indiana Series in the Philosophy of Technology. Bloomington: Indiana University Press.
- Ihde, Don. 1995. *Postphenomenology: Essays in the Postmodern Context*. Paperback. Northwestern University Studies in Phenomenology and Existential Philosophy. Evanston, Ill: Northwestern University Press.
- Ihde, Don. 2012. 'Can Continental Philosophy Deal with the New Technologies?', *Journal of Speculative Philosophy*, 26, 321–332.
- Jandrić, Petar, Jeremy Knox, Tina Besley, Thomas Ryberg, Juha Suoranta, and Sarah Hayes. 2018a. 'Postdigital Science and Education'. *Educational Philosophy and Theory* 50 (10): 893–99. <https://doi.org/10.1080/00131857.2018.1454000>.

- Jandrić, Petar, Thomas Ryberg, Jeremy Knox, Nataša Lacković, Sarah Hayes, Juha Suoranta, Mark Smith, et al. 2018b. 'Postdigital Dialogue'. *Postdigital Science and Education*, October. <https://doi.org/10.1007/s42438-018-0011-x>.
- Latour, Bruno. 2007. *Reassembling the Social: An Introduction to Actor-Network-Theory*. Clarendon Lectures in Management Studies. Oxford: Oxford Univ. Press.
- Lupton, Deborah. 2016. *The Quantified Self: A Sociology of Self-Tracking*. Cambridge, UK: Polity.
- Lupton, Deborah, and Annemarie Jutel. 2015. "'It's like Having a Physician in Your Pocket!'" A Critical Analysis of Self-Diagnosis Smartphone Apps'. *Social Science & Medicine* 133 (May): 128–35.  
<https://doi.org/10.1016/j.socscimed.2015.04.004>.
- Matthews, Adam. 2019. 'Design as a Discipline for Postdigital Learning and Teaching: Bricolage and Actor-Network Theory'. *Postdigital Science and Education*, March. <https://doi.org/10.1007/s42438-019-00036-z>.
- Matthews, Adam. 2020. 'Review of Andrew Feenberg (2017). *Technosystem: The Social Life of Reason*: Cambridge, MA: Harvard University Press. 235 Pp. ISBN 9780674971783 (Hardcover)'. *Postdigital Science and Education*, May, s42438-020-00125–4. <https://doi.org/10.1007/s42438-020-00125-4>.
- Monberg, John. 2005. 'Science and Technology Studies Approaches to Internet Research'. *The Information Society* 21 (4): 281–84.  
<https://doi.org/10.1080/01972240591007607>.

- Monforte, Javier. 2018. 'What Is New in New Materialism for a Newcomer?' *Qualitative Research in Sport, Exercise and Health* 10 (3): 378–90. <https://doi.org/10.1080/2159676X.2018.1428678>.
- Novatchkov, Hristo, and Arnold Baca. 2013. 'Artificial Intelligence in Sports on the Example of Weight Training'. *Journal of Sports Science & Medicine* 12 (1): 27–37.
- Pepperell, Robert and Michael Punt. 2000. *The Postdigital Membrane*. Intellect Books. <https://doi.org/10.13140/2.1.4499.4241>.
- Peters, Michael A., and Tina Besley. 2019. 'Critical Philosophy of the Postdigital'. *Postdigital Science and Education* 1 (1): 29–42. <https://doi.org/10.1007/s42438-018-0004-9>.
- Pinch, Trevor J., and Wiebe E. Bijker. 1984. 'The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other'. *Social Studies of Science* 14 (3): 399–441.
- Phoenix, C. (2010) 'Seeing the world of physical culture: the potential of visual methods for qualitative research in sport and exercise', *Qualitative Research in Sport and Exercise*, 2(2), pp. 93–108. doi: [10.1080/19398441.2010.488017](https://doi.org/10.1080/19398441.2010.488017).
- Purser, Aimie. 2018. "'Getting It into the Body": Understanding Skill Acquisition through Merleau-Ponty and the Embodied Practice of Dance'. *Qualitative Research in Sport, Exercise and Health* 10 (3): 318–32. <https://doi.org/10.1080/2159676X.2017.1377756>.
- Schwab, Klaus. 2016. *The Fourth Industrial Revolution*. First U.S. edition. New York: Crown Business.

- Selwyn, Neil. 2012. 'Making Sense of Young People, Education and Digital Technology: The Role of Sociological Theory'. *Oxford Review of Education* 38 (1): 81–96. <https://doi.org/10.1080/03054985.2011.577949>.
- Selwyn, Neil. 2019. *What Is Digital Sociology?* Cambridge, UK ; Medford, MA: Polity Press.
- Slack, Jennifer Daryl, and J. Macgregor Wise. 2005. *Culture + Technology: A Primer*. New York: Peter Lang.
- Smith, Merritt Roe, and Leo Marx, eds. 1994. *Does Technology Drive History? The Dilemma of Technological Determinism*. Cambridge, Mass: MIT Press.
- Sismondo, Sergio. 2010. *An Introduction to Science and Technology Studies*. 2nd ed. Chichester, West Sussex, U.K. ; Malden, MA: Wiley-Blackwell.
- Srnicek, Nick, and Laurent De Sutter. 2016. *Platform Capitalism*. Theory Redux. Cambridge, UK ; Malden, MA: Polity Press.
- Taffel, Sy. 2016. 'Perspectives on the Postdigital: Beyond Rhetorics of Progress and Novelty'. *Convergence: The International Journal of Research into New Media Technologies* 22 (3): 324–38. <https://doi.org/10.1177/1354856514567827>.
- Tanggaard, Lene, Dan Nørgaard Laursen, and Thomas Szulevicz. 2016. 'The Grip on the Handball – a Qualitative Analysis of the Influence of Materiality on Creativity in Sport'. *Qualitative Research in Sport, Exercise and Health* 8 (1): 79–94. <https://doi.org/10.1080/2159676X.2015.1012546>.
- Tegmark, Max. 2018. *Life 3.0: Being Human in the Age of Artificial Intelligence*.
- Verbeek, Peter-Paul. 2005. *What Things Do: Philosophical Reflections on Technology, Agency, and Design*. University Park, Pa: Pennsylvania State Univ. Press.

Weed, Mike. 2009. 'The Structure of (Social) Scientific Contradictions: A Commentary on the Problem of Paradigmatic Behaviour by Social Scientists'. *Qualitative Research in Sport and Exercise* 1 (3): 312–21.  
<https://doi.org/10.1080/19398440903192365>.

Wyatt, Sally. 2008. 'Technological Determinism Is Dead; Long Live Technological Determinism'. In *The Handbook of Science and Technology Studies*, edited by Edward J. Hackett and Society for Social Studies of Science, 3rd ed. Cambridge, Mass: MIT Press : Published in cooperation with the Society for the Social Studies of Science.

Zwift. 2020. 'Get Zwifing'. Zwift. 2020. <https://zwift.com/uk/get-zwifing>.