6. Technology as culture

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INTRODUCTION

There is a general consensus in the field of Science and Technology Studies (STS) that culture is fundamental to the study of technology's role in society, a key factor in the efforts to open the *black box* of technology. Since its inception, the field of STS has viewed various cultural dimensions as essential to shaping innovation and technology design, identifying a relevant nexus in the intersection between the cultural meanings of technology and its material forms and properties. Technology itself has been defined as the outcome of socio-material processes, emphasising the importance of the meanings and values embedded in artefacts, devices, and infrastructures, as well as the cultural contexts in which both technology producers and users are situated.

On closer examination, the STS focus on the interaction between technology and culture is embedded in the deep complexity inherent in both concepts of culture and technology. Technology is to be understood as the outcome of processes deeply rooted in the cultural context in which it emerges: its place in society is inextricably linked to the cultures that help shape its appropriation. The cultures and practices underpinning today's global society are increasingly dependent on distinctive technologies at the intersection of politics, communication, and the material construction of our everyday lives.

However, in the social sciences, it was not until the mid-twentieth century, especially after World War II, that technology became a subject of both public discourse and academic reflection, often revolving around the problematic idea that technology is an autonomous and inherently progressive force capable of modifying and determining culture and society. The deconstruction of this dominant *deterministic* interpretation has served as a starting point for a wide range of STS research aiming to better comprehend the numerous ways in which technology emerges in society as an assemblage of culture, materiality, and the practices that emerge from them. This perspective rejects the common sense notion that equates technology with mere 'things' and instead emphasises its processual nature, understood as the outcome of the intersection between technology's material features and its symbolic and discursive dimensions.

The following sections examine the development of some of the more distinctive STS trajectories in this consideration of technology as culture. This examination begins with the roots of the technology and society debate before outlining the various research paths at the intersection of technology and culture; it concludes by discussing some of the more recent STS contributions on the intersection of technology and culture, one focused on digital media technologies and the other on non-Western technologies, complemented by a postcolonial perspective on the technology–society–culture nexus.

THE EMERGENCE OF THE DEBATE ON TECHNOLOGY AND SOCIETY

Before delving into the core approaches developed in STS in the 1980s to address the societal and cultural implications of technology, an overview of the intellectual landscape from which the questioning of the technology–society nexus emerged in the mid-twentieth century is of use. During this period, some of the interpretations from the earliest critical thinkers on technology's role in society began to view technology less as a neutral tool than as an entity connected with other social, economic, and cultural influences, frequently arguing that technology had become a powerful and, to some extent, autonomous system. A significant figure during this period was American scholar Lewis Mumford. In his seminal work *Technics and Civilization*, Mumford (1934) pioneered a critical stance on the relationship between technology, society, and culture by considering how specific kinds of technology are directly connected with either authoritarian or democratic regimes, thus locating the transformative power of technology in its essential technical features. In the 1950s, French thinker Jacques Ellul elaborated a pessimistic view of technology, which he saw as an autonomous force urging humans to adapt to a rationalising logic. Previously, in the 1920s, American sociologist William Ogburn coined the term 'cultural lag' to refer to the way technical and material transformations anticipate and drive social changes, arguing that culture can be viewed as a secondary adaptation to technical evolution.

This composite landscape of thinkers on the relationship between technology and society sparked debate around the importance of technology to social organisation. One recurrent view was that technology was not only capable of impacting society because of its technical features but that it was autonomous and independent of social processes. The extreme version of this viewpoint can be described as 'technological determinism', that is, a reductionist attitude to the role of technology in society that suggests that technological development is the primary driving force behind social and cultural changes. As a result, technological determinism fails to recognise the mutual construction between the technical dimension of technology and the culturally embedded practices and relationships that support its development. This deterministic view has persisted until today in public discourse as well as in several scholarly approaches; it tends to foreground the 'effects' or 'impacts' of technological change on society and culture rather than reveal the social, cultural, and economic processes underpinning the emergence of new technologies. For STS scholars, this viewpoint fails to acknowledge the interactive relationship between technology, society, and culture and the heterogeneous elements contributing to this relationship. The critique of technological determinism was a crucial starting point for STS to offer a more nuanced and articulated view of the role of technology in society. Early STS approaches sought to refute technological determinism, drawing on several significant 1970s intellectual movements that questioned the technology–society relationship. One of these movements emerged from new trends in the history of technology that challenged linear historical-technological development narratives and other deterministic views on the consequences of technology for society. One of the most frequently cited examples of linear historical narratives is the work of historian Lynn White, who directly attributed the emergence of feudalism to the adoption of stirrups. Historians such as Thomas Hughes (1983) and Ruth Cowan (1983) substantially contributed to acknowledging the complex interaction between technology and social change. Two notions introduced by Hughes were especially relevant to attempts in the early STS debate to provide a more sophisticated approach to the

history of technology: 'technological momentum' and the 'seamless web of technology and society'. With the notion of technological momentum, Hughes offered a perspective on the technology–society interaction capable of supplementing a social constructivist view with the need to address technology's tendency to develop in particular directions as it grows, following seemingly autonomous paths once basic social choices have been made. Hughes's. Seamless web, on the other hand, was coined to describe the interconnectedness of technologies, institutions, and practices emerging as a unified whole, emphasising that technologies are not isolated entities but are, in fact, seamlessly interdependent with all other social, cultural, and material elements relevant to their development. Feminist historians of technology also made a distinctive contribution to the understanding of technology as part of a wider relationship framework, especially by highlighting the gendered nature of technology. For instance, in her work on the history of household technologies, Ruth Cowan (1983) showed that gender relationships influence the design and appropriation of domestic tools in the process of defining the modern home.

A further movement contributing to the early STS debate on technology in the early 1980s emerged in political philosophy. In his influential article 'Do artifacts have politics?', Langdon Winner (1980) elaborated on the idea that technologies can embody social relations, arguing that technological design and adoption are intertwined with the social order that produces and supports them; for instance, technical artefacts may emerge in close interaction with political purposes. In the early 1980s, the STS debate on technology was further influenced by the Marxist intellectual tradition that criticised industrialisation and capitalist labour organisation, viewing technology primarily as the consequence of capitalist logics and processes. These reflections contributed to a shift from an emphasis on technology's effects on society towards a discussion of the extent to which technologies are both deeply embedded in social, economic, and cultural conditions and actively reshape them.

One of the earliest contributions to connecting these intellectual currents with a more explicit STS problematisation of technology in society was MacKenzie and Wajcman's *Social Shaping of Technology* (1985). Presenting a selection of some of the main contributions discussed above, this collection contributed to paving the way for a more organic social science debate on the technology–society relationship. In particular, with its attention to the ways in which industrialisation and capitalism shape technological change in modern societies, this volume was an important step in the direction of a more comprehensive consideration of technology in society in the social sciences. This perspective, with its basis in the notion of the 'social shaping of technologies', directly questioned technological determinism by showing that technology is not independent of society and that societal characteristics exert a crucial influence on technical innovations.

THE TURN TO TECHNOLOGY IN STS: SCOT AND ANT

In the mid-1980s, early STS scholars who were originally more interested in science began turning their attention to technology, marking a departure from a focus on the production of scientific knowledge to a distinctive problematisation of technological artefacts. In STS, the drive for a more robust consideration of the interaction between the materiality of artefacts, their meanings, and the ways they are appropriated in practice by various social actors coalesced in the mid-1980s around two major frameworks designed to foster our under-

standing of technology's role in society: the Social Construction of Technology (SCOT) and Actor-Network Theory (ANT; see entry 2, this volume).

The SCOT approach, introduced by Trevor Pinch and Wiebe Bijker (1984), represented a pioneering attempt to provide a structured model for use in analysing technology's emergence as a result of social, cultural, and material dynamics. Directly drawing on the Sociology of Scientific Knowledge (SSK) and the Empirical Programme of Relativism (EPOR), SCOT rejected the idea that new technologies emerge in society as the most efficient solutions to self-evident problems, instead positing that successful artefacts are not inevitable outcomes but contingent results arising from the interaction between technologies and the social actors involved in their design and appropriation (Bijker, Hughes and Pinch, 1987). According to this perspective, the processes involved in the social construction of technology pivot around the notion of artefacts' *interpretative flexibility*—that is, the fact that, especially in the early stages of innovation processes, technologies can be interpreted in different ways by different *relevant social groups* with distinct needs capable of using technologies to develop novel social identities.

The SCOT approach highlights the importance of understanding that technologies are deeply embedded in the social and cultural processes shaping their adoption. It challenges the notion that technologies emerge linearly as a mere response to predetermined problems and instead emphasises the role social actors play in reshaping artefacts' meanings, uses, and needs. It also considers artefacts' interpretative flexibility as central to understanding technology trajectories in society, thus emphasising the role played by rhetorical and cultural framing in shaping their potential uses, the identities of their users, and even the problems they are designed to solve. Finally, SCOT's recognition of end users' role in shaping technological innovation paved the way for subsequent STS research focusing on the complex relationships between technology, its users, and their cultures (Oudshoorn and Pinch, 2003).

The second major framework of reference, ANT, emerged in STS in the mid-1980s to make sense of the technology–society relationship. ANT was developed by several scholars, including Bruno Latour, John Law, and Michel Callon, and was formulated in a less systematic way than SCOT. Its conceptualisation of technological (and scientific) evolution is based on the ways in which interactions between heterogeneous sets of human and non-human actors crystallise into stable relationship networks (see for instance Latour, 1987). One of ANT's main contributions was its call to consider both humans and technical artefacts as agential in the unfolding of innovation processes, foregrounding the role of material artefacts in shaping the social world, one seminal example being Michel Callon's (1987) analysis of the development of electric vehicles in France in the 1970s, in which he illustrated the process of bringing together in a stable actor-network fuel cells, electric vehicles, industrial firms, and the consumers who had to accept the use of these new artefacts. In this framework, which has also been described as a 'material semiotic' approach, meanings acquire a crucial role as part of the process by which networks of relationships between heterogeneous entities are formed.

ANT's integration of the cultural dimension into the understanding of technology adopted various conceptual nuances. Michel Callon's (1986) articulation of ANT—also referred to as a 'sociology of translation'—placed special emphasis on the discursive definition of the problems driving innovation processes, the attribution of specific identities to the actors involved, and the way in which the collectives involved in the process could be successfully represented in the construction of relationship networks. A further important contribution was made by Madeleine Akrich (1992), who argued that technologies contain a 'script'—a dis-

tinctive vision of how technologies should be used and how they can be assigned specific competencies and responsibilities. Steve Woolgar's (1990) notion of 'configuring the user' further underscored that users' interpretations of technology are framed by designers' efforts to define the identities of putative users and set constraints upon their expected future actions.

The ANT framework has moved in multiple directions and has been appropriated by several fields in a wide range of alternative and substantially different ways to form a heterogeneous landscape of approaches, sometimes referred to as post-ANT or after-ANT. Overall, ANT-inspired theories became central to outlining the processual and performative dynamics in the construction and appropriation of technologies, all while foregrounding the materiality of artefacts as crucial to uncovering technologies' social and cultural nature (see Michael 2000).

MULTIPLE STS PATHWAYS TO THE STUDY OF TECHNOLOGY AS CULTURE

Following the advent of the SCOT and ANT approaches, the field of STS moved in many directions in its attempts to explore the social and cultural dimensions of technologies, intersecting with other intellectual trajectories and social science fields. Within this multiplicity of directions, at least five distinct pathways can be identified that, though not encompassing the vast body of STS literature in its entirety, provide a good sense of the various articulations that have emerged in social studies on technology.

The first pathway involves the integration of feminist approaches into the STS framework in response to the need to explore the gendered character of technology (see entry 9, this volume). Feminist approaches have intersected with technology studies in various ways, highlighting issues of identity and social roles as crucial analytical dimensions. This pathway can primarily be traced back to the work of feminist historians of technology, such as Ruth Cowan. In the aforementioned influential study of housework technologies and tools, Cowan (1983) examined the introduction of technologies within industrialisation and women's related social and family roles, conceptualising domestic technologies as part of evolutions in the gendered division of household activities and the social organisation of the family. Cynthia Cockburn's (1983) work was more directly influenced by Marxism and viewed the adoption of technology and technology-related gender differences as outcomes of wider evolutions in capitalist organisation and labour relationships. These and other works provided the basis for a solid integration of feminist approaches into the study of technology, which then branched out in different directions (Wajcman, 2004) emphasising that the gendered construction of technology is a component of countless technologies, including the male contraceptive pill (Oudshoorn, 2003).

At the intersection between STS and feminist cultural studies, Donna Haraway's (1985) *Cyborg Manifesto* was highly influential in bringing new insights from the feminist debate into the development of early STS frameworks. In contrast to the prevalent feminist views of technology at that time, Haraway emphasised its progressive and emancipatory potential to create new meanings and identities, highlighting the need for a more robust cultural analysis of technology's role in society. Particularly noteworthy is Haraway's view of feminist science fiction as a valuable resource for technoscience studies, identifying literary studies as

an additional tool that can be used to examine how social meanings surrounding science and technology are shaped.

A second STS pathway to understanding the technology's embeddedness in cultural processes can be found in the work of scholars who focus on the role of narratives, discourses, and imaginaries in shaping innovation processes and technology-related policies. Emerging in the 1990s, this strand of research emphasised the role of expectations and the ways in which visions of future science and technology outcomes shape innovation processes in the present (Van Lente and Rip, 1998; see entry 42, this volume). In this view, innovation processes require *expectations* or *promises* to develop around their future positive outcomes. A crucial point here is that expectations and promises play a *performative* role: while seemingly related solely to the future, they are actually designed to mobilise resources in the present, for example, in the form of investments, favourable regulations, or public support. Within this research current, the need for a broader cultural understanding of the societies that produce technological innovation occupies a prominent place, which is what the notion of 'sociotechnical imaginaries' aims to speak to. Sociotechnical imaginaries consist of 'collectively imagined forms of social life and social order reflected in the design and fulfilment of nation-specific scientific and/or technological projects' (Jasanoff and Kim, 2015: 4). This notion has been used to shed light on the ways in which social, normative, and institutional future-oriented visions can channel collective choices, preferences, and practices regarding desirable or unwanted technologies.

The attention paid to the future consequences of technologies, and their influence on shaping innovation intersected with two other significant perspectives centring on the relationship between technology and cultural representations. The first of these, the field of *public understanding,* or *public communication of science and technology* (Bucchi and Trench, 2008; see entry 23, this volume) highlighted the role media play in shaping the meaning and representation of science and new technologies in society, focusing on the positive, negative, or ambivalent ways people interpret these innovations. The second connection was the uptick of scholarly interest in fictional representations—including films, literature, and comics—to aid our understanding of technologies and emerging innovations. STS's interest in science fiction is rooted in the recognition that popular cultural representations are part of a wider expectation and imaginary construction process at the intersection between science and fiction with which scientists themselves can directly engage in fictional imaginative production (Kirby, 2011), highlighting the porous boundaries between real technical innovations and their fictional counterparts.

A third pathway in the quest to understand technology emerged in the 1990s, primarily through Susan Leigh Star's work, and involved the conceptualisation of complex technologies as *infrastructures* consisting of heterogeneous elements that take part in their construction and ensure their proper functioning (Star and Ruhleder, 1994). Infrastructure studies examined the intersection between technical infrastructure elements and wider social dynamics, emphasising that infrastructures that exist in the background of user experiences are often invisible and frequently taken for granted (see entry 34, this volume). Several concepts were introduced to describe the processes bound up with building and using infrastructures, and new methods were proposed to study them. One such concept was 'infrastructural inversion', which served as a methodological strategy to foreground the invisible work underlying technological functioning and shift attention to the often-secondary activities that enable technical infrastruc-tures to function properly. This led to the notions of 'maintenance and repair', which gained prominence in this context by highlighting the importance of practices and cultures related to

keeping infrastructures operational by managing and fixing issues. This perspective has also enriched our understanding of the role of the objects, tools, and other technologies that ensure the proper functioning of infrastructure.

A fourth research pathway consists of work expressly focusing on the part users and their cultures play in directly shaping innovation processes (see entry 35, this volume). Building on SCOT's early conception of users as actors with distinct needs and direct involvement in constructing meanings around technologies, the role of technology use was viewed as a crucial analytical focus to understand how social and cultural elements are embedded in technical artefacts and the way wider social and cultural dynamics contribute to creating innovation paths (Oudshoorn and Pinch, 2003). The role of users in understanding technology was exemplified by Lucy Suchman's (1987) seminal work on photocopiers, in which she highlighted how the situated use of machines and people's responses to them were constitutive of the life of technologies in their social context, and that all this was highly relevant to technology designers and firms. Challenging common notions of designers and engineers as the main actors in technology creation, the user studies field emphasised that users contribute to the shaping of technologies in different ways and on different levels: materially, modifying the tools they use; symbolically, altering technology's meanings; and practically, using technologies for different purposes. The user studies field has thus viewed ordinary people and consumers as crucial agents in technological change.

This reflection on users also evolved into a consideration of the way their potential to actively contribute to innovation processes is turned into a resource for technology producers and firms, highlighting the multiplicity of strategies adopted to engage users and exploit their knowledge and perspectives (Hyysalo et al., 2016). This view illustrates that users, with their distinct practices and cultures, are at the heart of the tensions and controversies crucial to technological development and its social appropriation. However, it is also important to note that within this view users were also conceptualised as *consumers* in recognition of the broader role that consumer cultures, practices, and everyday social routines play in the evolution, acceptance, and even abandonment of everyday technologies (Shove, 2003).

Finally, a fifth pathway of use in understanding the various forms bound up with the relationship between culture and technology are the few cases in which the STS field has engaged in direct dialogue with the humanities to address the role of technology in shaping art, culture, and aesthetic content. Despite STS's tendency to move in multiple directions and cross-pollinate with a range of disciplines and approaches, connections with art, aesthetic, and pop culture disciplines have proved more difficult to establish. The most notable example of cross-fertilisation between STS and the arts and humanities is its intersection with music studies, which gave rise to the subfield of *sound studies*, in which STS scholars played a pivotal role (Pinch and Bijsterveld, 2012). The music context has provided a fruitful terrain for STS scholars' attempts to disentangle the intimate and somewhat sacral relationship between technical artefacts, artistic practices, and their aesthetic outcomes from the perspectives of both music producers and listeners. The STS field has thus made a decisive contribution to music studies by offering a framework in which to enquire into the complex interaction between human creativity and technology mediation, especially in relation to the role of musical instruments and other technical tools for music creation, circulation, and consumption (Pinch and Trocco, 2002).

EMERGING TRAJECTORIES: DIGITAL MEDIA TECHNOLOGIES AND NON-WESTERN TECHNOSCIENCE

Evolutions in studies of the technology–culture nexus in STS are ongoing as its theoretical perspectives and preferred objects of study multiply and intersect constantly with other intellectual fields and traditions. Distinctive trends in the various recent developments in contemporary technology studies include a consideration of the role played by digital media technologies in every aspect of our social lives and a focus on non-Western technologies, which is accompanied by a postcolonial perspective on technoscience studies.

One recent development in expanding the thematisation of technology's role in contemporary society is the shift towards media technologies, which have been recognised as crucial to understanding the nexus between technology and culture. Although STS scholars' interest in media technologies consolidated only in the second decade of the twenty-first century, debates on technological determinism relating to media emerged as early as the 1970s, primarily in response to Marshall McLuhan's media theory, which was often associated with an 'essentialist view' on the role of media in society. It was not until the early 1990s that there was a first convergence between STS and media studies with the domestication theory developed by the British qualitative media analyst Roger Silverstone, who examined the entanglement of television and other domestic media devices with family relationships (Silverstone and Hirsch, 1992). Domestication theory scholars emphasised the importance of the material and symbolic appropriation of media technologies in understanding how media are embedded in everyday relations, with a particular focus on the social and cultural organisation of the household. Their focus on the complex cultural dynamics that characterise technology appropriation was consistent with the emerging STS focus on the entanglement between the material and symbolic dimensions of technology (Lie and Sørensen, 1996).

While the convergence around domestication theory created a common ground for STS, media sociology, and consumer studies, media technologies remained largely outside the core interests of STS scholars until the 2010s (see entry 52, this volume). Until then, media and communication were predominantly subjects of the humanities or political science, disciplines whose approaches focused mainly on content and texts rather than practices and materiality. The relevance of media technologies as a distinct STS subject was recognised particularly after the internet and other digital communication tools began to take centre stage in all social activities and everyday practices (Gillespie, et al., 2014).

The STS perspective fruitfully complemented media studies by emphasising the material and technical dimensions of media technologies, which began to be interpreted as sociotechnical assemblages deeply embedded in historically situated social and political contexts (Boczkowski and Lievrouw, 2008). The study of media technologies in STS gained significant traction at the end of the 2010s, especially as a range of digital phenomena, including social media and other digital platforms and algorithms, gained prominence and the datafication of user behaviour became tangible (Marres, 2017). The ability to consider a range of heterogeneous elements at the intersection of the technical, the political, and the symbolic has given STS a prominent place in the study of the central role that digital data circulation, algorithms, and digital platforms have assumed in today's rearticulation of the relationship between technology and cultural flows and the associated social ties that underpin them (van Dijck et al., 2018; see entries 53 and 54, this volume). Therefore, despite some delay, STS's shift to media

technologies offers a new perspective on the evolving relationship between culture, technology, and society in the contemporary digital world.

A further emerging trend in STS research on technology as culture is an increasing focus on non-Western technologies. This research attempts to incorporate new theoretical perspectives capable of offering a more articulated understanding of technologies in non-Western cultures, including postcolonial reflections on the STS intellectual landscape. Overall, there has been growing recognition within STS of the importance of studying and understanding science and technology from more global and inclusive perspectives by incorporating postcolonial sensibilities, a trend which is also increasingly visible in other areas of the social sciences (Harding, 2011). With the new millennium, STS scholars have sought to challenge Western-centric bias in the study of technology by examining diverse non-Western practices, knowledges, and artefacts. This has involved exploring how technology is developed, used, and understood in different cultural, social, and institutional contexts and exploring how these differences can provide new insights for the development of STS theories and concepts to advance understanding of the technology–culture nexus.

At the thematic level, this trend has involved expanding fields and objects of study into wider and more diverse geographical contexts beyond the mainly US and European case studies STS referred to in the late twentieth century. Analysing the sociotechnical assemblages that emerge in relation to technological practices in non-Western contexts has provided new insights into common themes in STS, such as the fact that technoscience is not a universal phenomenon and that power and influence in global innovation processes are far from evenly distributed around the world.

At a more analytical level, postcolonial-influenced STS emphasises the agency, resistance, and alternative knowledges of non-Western societies and seeks to highlight the creative adaptations and hybridities that emerge in non-Western contexts, thus challenging Western-centred notions of progress and development (see entry 12, this volume). This includes acknowledging and engaging with the contributions non-Western cultures have made to the shaping of technological progress and outlining the part they have played in the production of alternative sociotechnical assemblages. Here, the emphasis remains on the cultural dimension of technology, which has characterised STS throughout its history and has been the basis for foregrounding and interrogating diverse ways of knowing and understanding technology in different cultures. This STS interest in non-Western alternative versions of the intersection between technology and culture has been supported by a more robust collaboration between STS and anthropology of technology (Bruun et al., 2022). These two perspectives converged both in the need to study the local embeddedness of technologies in non-Western countries and with a shared methodological approach that privileges intensive fieldwork methods to capture the social and cultural elements shaping technological artefacts.

Finally, this trend has also translated into a particular emphasis on decolonising STS research and its tools, thus challenging the Western-centric origins of STS concepts and assumptions for studying technologies. Incorporating postcolonial sensibilities into STS has also translated into a specific emphasis on questioning the rootedness of STS's theoretical frameworks and concepts, as they emerged mainly from US and European cultural and political contexts. In this regard, as Law and Lin (2017) have suggested, in the near future STS should engage more robustly in developing a *postcolonial symmetry*, a postcolonial version of the STS *principle of symmetry* that would treat non-Western and Euro-American STS views and approaches to the study of science and technology in a more balanced way.

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