Tech workers as producers of technology in digital capitalism
Towards a revitalised conceptual framing of technical experts in social conflicts

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ABSTRACT

Since 2017, new conflicts for tech workers in the digital economy have been emerging. These mobilisations have included speaking out against the unfavourable social outcomes of the digital technologies they develop. Against this backdrop, this article asks how the role of technical experts as producers of technology in social conflicts can be understood. In order to examine this question, historical and contemporary research on the political interests of engineers and tech workers is reviewed. Utilising class theories of the new middle classes, three research strands are distinguished: proletarianisation studies, technology studies and profession studies. Whereas the first is mostly applied to the analysis of contemporary conflicts in tech, the latter two carry the potential to understand the role of tech workers as producers in social conflicts. The article discusses how these concepts can be updated to investigate conflicts around technology in digital capitalism.

Introduction

In recent years, a new wave of political activism driven by highly qualified tech workers has hit the Big Tech and platform industries as well as other sectors of the digital economy, including walkouts against sexual discrimination (Tarnoff, 2020),

the establishment of Tech Worker Coalitions (TWCs) that have protested against the social and ecological consequences of digital technologies (Weigel, 2017) and new unionisation processes such as the Code CWA campaign of the Communication Workers of America (CWA) to organise workers in Big Tech companies and start-ups.

One feature of these tech workers' political mobilisations was their criticism of the outcomes of digital change in society and the business models of the digital economy. In 2017, 2000 Google employees demonstrated against supplying the Trump administration with digital tools to enforce the Muslim ban. In 2018, the company's software engineers stopped Project Maven, in which Google -was working with the Pentagon to develop AI-supported drones. Open letters and the refusal of a responsible development team to work put an end to the project. In the same year, Google employees spoke out against the plan, known as Project Dragonfly, to introduce a censored search engine to the Chinese market. This was followed by open protests by Microsoft Salesforce and Amazon employees against their companies' cooperation with US border authorities (Tarnoff, 2020). Furthermore, the dismissal of AI expert Timnit Gebru, who was conducting research into racial and gender discrimination through machine learning models on behalf of Google, provoked open resistance from the company's employees (Metz & Wakabayashi, 2020). In addition, activist groups such as Tech Workers for Climate Justice, in which, among others, Amazon tech workers were active, drew attention to the ecological damage caused by digital corporations.

This organising cycle of highly qualified tech workers was remarkable for two reasons. First, they were not regarded as a group of workers with any particular affinity for collective organising. Trade union organising had only rarely been observed among them in recent years, and, where this has been the case, these have been notable exceptions (Boes & Trinks, 2006; Ittermann, 2009; Rothstein, 2022). Their orientations were considered to be largely in line with entrepreneurial subjectivities (Barbrook & Cameron, 1995; Turner, 2006; Neff, 2012; Wajcman, 2019a). Second, the tech worker movements are centred, particularly on issues related to the alternative orientation of digital change. By adopting this orientation, these workers focused politically on their role as producers of technology, questioning to what extent their technological expertise is used by the digital companies they are working in to create disadvantageous effects on society. These interests are rarely expressed in the industrial relations of organised worker movements. Workplace conflicts are usually mobilised around wage issues and the quality of working conditions, rather than the purpose of production and work (Korsch, 1922; Blanke, 1995; Müller-Jentsch, 1995). In these tech worker movements, however, tech workers were demanding an alternative use of digital technologies and a say in the design of their products.

Against this backdrop, the question arises of how tech workers in the digital economy can be understood as producers of technology in social conflicts. Understood as highly qualified technical experts involved in the design of digital technologies in the Big Tech and platform industries which have emerged since the financial crisis (Dorschel, 2022b; Ziegler, 2022), tech workers have a special responsibility for the direction of digital change and its social impact. What is questionable is the extent to

which they engage in workplace disputes by designing technology, utilising their technical expertise and demanding an alternative orientation of technical change.

Historically, several research strands have considered such questions in relation to technical expert workers. In the field of class theory. as well as within the sociology of work and professions, a number of theoretical and empirical works have investigated the position of technical workers in social conflicts, ranging from the role of engineers in corporate production after the Second World War to the rise of IT workers in the digital economy. This article aims to reconstruct these research strands in order to tease out theoretical concepts which can help us understand how tech workers are embedded in social conflicts through their roles as producers of technology.

The first step in this analysis draws on scholars who conceptualised technical expert workers as a new middle class between capital and labour (Carchedi, 1975; Poulantzas, 1975; Ehrenreich & Ehrenreich, 1979; Wright, 1979, 1985). Using this concept, technical workers can be situated in social conflicts along three axes: their exposure as workers to wage inequality and corporate control; their role in managing social conflicts by designing technology for capitalist corporations; and their engagement as professionals to appropriate control in corporations and the societal division of labour by using their technical expertise.

In a second step, these conceptual axes of social conflicts are utilised to categorise historical research on engineers and contemporary studies on tech work in digital capitalism into three strands: *proletarianisation studies*; *technology studies*; and *profession studies*.

This paper aims to show that, while most of the contemporary research on tech workers in digital capitalism focuses on their *proletarianisation,* through falling wages and deteriorated working conditions, as a driver of their political mobilisation, the threads of historical *technology* and *professions studies* have not yet been picked up, despite carrying considerable potential for understanding contemporary social conflicts around the orientation of technical change in the digital economy. However, in order to make a useful contribution to the contemporary research agenda on digital capitalism, these approaches need to be updated.

Technical workers as a contradictory middle class

Theories of the new middle classes can deliver a general framework for situating technical expert workers in conflicts on social inequality. Following Marxist assumptions, they understand the social structure of modern societies as shaped by conflicts between capital and labour over the control of economic activities and wealth distribution (Wright, 2015:9f.; Dörre, 2022:25f.). Especially in relation to the position of engineers in post-war corporations, several theoretical approaches emerged, which differentiated this class schema and acknowledged the establishment of worker fractions as intermediate classes between capital and labour (Carchedi, 1975; Poulantzas, 1975; Gorz, 1976; Ehrenreich & Ehrenreich, 1979; Wright, 1979, 1985). These diagnoses describe the ambiguous situation of technical expert workers in three aspects.

First, the position of technical expert workers was seen as ambivalent because while, on the one hand, they do not own capital to steer corporations, on the other, they are only partially proletarianised because they occupy privileged positions in capitalist corporations. In principle, theories of the new middle classes distinguish three central goods enabling the control of economic activities and thus constituting class relations in society. These comprise the control of economic investment resources, control over the expenditure of labour and the development of production technology which, they argue, determine the distribution of classes in society. While the first of these (the control of economic investment resources) can be described as legal ownership of economic resources, the second and third (control of labour and the development of production technology) signify factual possession of production expertise (Poulantzas, 1975:207; Wright, 1979:73). In this analysis, proletarianisation can be understood as the cumulative effect of all the developments that transfer control of economic activities to the side of capital. Thus, it is not limited to separating workers from legal ownership of production resources. Capital owners can buy labour, materials and technology on markets, but the simple fact of owning them does not mean that they can actually carry out work and organise production. The latter ability is essentially linked to the possession of production expertise. Managerial strategies of de-qualification, devaluation and control of work are then understood as instruments for shifting power over economic activities to capital. Against this backdrop, technical experts were seen as *partially* proletarianised since they are wage dependent – i.e. they have no means of investment – but nevertheless possess critical technical expertise enabling them to control economic activities in the corporate division of labour, to be less affected by managerial supervision than lower-qualified workers and thus able to enforce higher wages (Wright, 1979:73–79).

Second, the position of technical experts was seen as ambivalent with regard to their role as *producers of technology* within the labour process. For this understanding, theories of the new middle class distinguish between working tasks that create use-value-oriented prosperity and those that are supposed to result solely from the capitalist organisation of labour. The fractions of workers belonging to 'productive labour' (Poulantzas) or the 'global worker' (Carchedi) are understood as ensuring efficient production or the development of high-quality products; other workers belonging to the 'global capital' (Carchedi) are concerned with the hierarchical supervision of other workers or the economic management of the company – tasks that can be seen as resulting solely from capitalist class relations. Following these assumptions, technical workers, by developing technology, are involved in the creation of use values and take on 'global functions of the collective worker' (Carchedi, 1975:13–33; Poulantzas, 1975:230–245). But they also enforce managements' interest in rationalising the labour process and controlling other workers. By doing so, they take on the global functions of capital, understood as those tasks needed to increase corporate profits by organising the activity of other workers (Carchedi, 1975:24). This assumption mirrors diagnoses according to which technology in capitalist corporations is strategically implemented by management to determine and supervise the working activities of employees (Braverman, 1974:155–250).

Third and subsequently, they were seen as occupying an ambivalent position, because as professional workers they *appropriate production expertise*, but only by expropriating it from other worker fractions. As professional expert workers they partially influence the development of technology and the organisation of work. Thus, an absolute monopolisation of production expertise among the group of capital owners is not realised. Rather, non-owners of investment resources possess comprehensive expert abilities to organise production. However, this production knowledge of technical experts was seen as resulting from a historical expropriation of the knowledge of other workers (Ehrenreich & Ehrenreich, 1979). This assumption refers to diagnoses according to which the emergence of technical professions in corporations is regarded as causally linked to the deskilling of other employees because technical experts use their sophisticated knowledge to embed tasks into technology, that were previously performed by skilled production workers. (Panzieri, 1972; Gorz, 1976; Schmiede, 1983) For example, programmers of numerically controlled (NC) tool machines, one of the first groups of IT workers in industrial corporations, took over the task of steering machine tools which was previously done by skilled lathe operators (Noble, 1979).

Researching technical workers in social conflicts and digital capitalism

These three dimensions structuring the ambivalent position of technical workers can be utilised to categorise three research strands (discussed below) on their role in social conflicts. First, because technical experts are not fully affected by the unequal access to the means to control economic activities, some scholars have investigated to what extent these privileges are diminished by processes of *proletarianisation*. Second, because these experts control other workers, other scholars have explored how they manage social conflicts by *producing technology*. Third, since they possess sophisticated production expertise, another research strand has looked at how they *professionally appropriate* corporate decision-making and thus challenge corporate management.

The approach adopted in proletarianisation studies is historically well established and still often utilised to understand contemporary conflicts of tech workers. This approach implicitly attributes the drivers of their political organisation to their passive interest in being protected from wage cuts and corporate control. By contrast, scholars in the fields of technology and profession studies have historically highlighted the position of tech workers as active technological designers and agents of appropriation, regarding these as a source of their interests. These fields can thus contribute to the development of an agenda to research tech workers as producers in digital capitalism.

Proletarianisation studies

Because technical experts benefit from their privileged position within company hierarchies, theories of the new middle class conceived their devotion to collective organising as only possible if they are shifted to the proletarian pole of labour. Hence, most theoretical studies of the new middle classes assumed that dequalification,

devaluation and control of work would also reach those comfortable zones of technical professions in the long term and would thus make technical experts open to collective organising (Deppe, 1973:85; Poulantzas, 1975:248f.; Wright, 1985:125; Smith & Willmot, 1991:22–24).

Many empirical studies of the labour processes of technical experts have followed this assumption. In a German engineering study in the automotive and machine tool industries in the 1970s, for example, it was observed that the interests of engineers and technicians differed depending on their position in the company. The attitudes of those who worked as technicians at the lower levels of the company hierarchy and had less decision-making power moved closer to the interests of production workers. Above all, they feared a further intensification of their work and job cuts and were in favour of joint representation with other workers. By contrast, Research and Development (R&D) engineers, due to their privileged position, emphasised the importance of individual performance against efforts of collective organisation (Beckenbach, 1975:287–285).

Empirical studies of the interests of IT developers also adopted this perspective. Following the collapse of the internet economy at the end of the 1990s, various surveys in German IT service companies examined the demands of IT specialists who were affected by crisis-induced rationalisation. They found that IT workers developed collective interests to secure their jobs, but also to preserve workplace autonomy and autonomous work cultures (Boes & Trinks, 2006; Ittermann, 2009). Furthermore in the course of the growth of the software industry in the 1990s, some studies diagnosed an increased industrialisation of software development through standard products and the introduction of bureaucratic development processes (Beirne, Ramsay & Panteli, 1998; Barrett, 2001, 2005). As in the history of engineering work, this led to a polarisation of IT work between routine activities, such as testing and debugging, and creative activities with a high degree of work autonomy, such as software engineering and product design (Barrett, 2001; Marks & Scholarios, 2007; Marks & Baldry, 2009).

All of these empirical studies focus on how technical experts are affected by corporate domination and economic insecurity. Hence, they understand the workplace politics of technical workers primarily in relation to protective organising against rationalisation and job cuts. Contemporary studies of the situation of tech workers in the digital economy pick up this thread. Roy (2021) researched the precarious situation of Indian tech workers and whether it is a source for collective union affiliation. But, she concludes, since they still are privileged by flexible working cultures and less organisational control, tech workers do not see a need for collective organising. Steinhoff (2022) makes predictions about the proletarianisation of data science. He identifies the expansion of educational programmes to increase labour market supply and the automation of data collection and model building through the use of new AI tools as mechanisms that deprivilege data scientists by devaluing their production expertise. Dorschel (2022a) also points out that data scientists and user experience designers as a new fraction of tech workers form critical attitudes towards self-exploitation and excessive managerial performance demands, which can be understood as subjective defence mechanisms against proletarianisation.

Beyond that, other new studies of labour conflicts of tech workers implicitly assume that processes of proletarianisation are setting the stage for them to organise collectively. One example of this is the research on the movement of Chinese tech workers against extended working times by Tan and Weigel (2022). Another is the case study by Rothstein (2022) of the collective resistance of tech workers at IBM and Siemens against job cuts and dismissals which investigated how highly qualified IT professionals mobilise specific power resources to confront management initiatives.

We can conclude that most of the contemporary research which has arisen in response to the new tech worker movement has followed this proletarianisation approach. It has, however, been less illuminating in relation to the significant interests of tech workers in their role as technological producers. To investigate this, other research strands might deliver promising conceptual frameworks.

Technology studies

In contrast to the studies that focus on proletarianisation, other research from the 1970s and 1980s on technical expert workers was less concerned about their exposure to economic insecurity than other issues. Rather, they investigated how technical workers were themselves reproducing social inequality by developing technology for capitalist corporations and implementing the rationalisation of production. In particular, Smith's (1987) empirical case study concentrated many findings that can also be found scattered across other studies. In his investigation of the Concorde production side of British Aerospace in Bristol, Smith analysed the attitudes of engineers and technicians to the design of technology and their relations to other workers – from rate fixers who set rates for production lines to programmers of NC machines and design engineers.

As Smith pointed out, engineers organising the labour process in the upper technical departments were particularly likely to distance themselves from production workers and downplayed the significance of the latter's practical knowledge of the labour process. As a result, they were also more likely to promote the use of technology for deskilling other workers. Design engineers who worked in offices separated from production and who designed templates for assembly plans emphasised the superiority of cognitive-technical skills and devalued manual production work. This also corresponded to technical design concepts in which human activity was seen by them primarily as a source of disruption to the production process. For example, engineers who developed CAD technology for technical draftsmen were willing to replace the manual expertise of the draftsmen in drawing construction plans. They considered the manual activities of workers to be technically inaccurate and imagined manual work as unpleasant and in need of automation, ignoring the fact that for the draftsmen it constituted the core of their craftsmanship (Smith, 1991). However, Smith also observed that there was some potential for these technical experts to question hierarchical divisions of labour and the control of workers by technology. The more closely the engineers and technicians cooperated with production workers on a daily basis, he concluded, the more they recognised the importance of manual work for the production process. NC programmers, for example, who programmed software for machine tools and frequently exchanged information with tool operators, valued the experience of those production workers because it enabled them to programme the

machines more effectively and thereby brought into question a strict division of labour (Smith, 1987: 130–189).[1]

Many other studies from the 1970s and 1980s, in which the attitudes of engineers in a plant for consumer electronics (Volmerg, Leithäuser & Senghaas-Knobloch, 1986), plants for aircraft, motor vehicle and machine tools (Beckenbach, 1975) and a large application-oriented research institute (Engelhardt & Hoffmann, 1974) on the design of technology were examined, came to similar conclusions. They encountered engineers who regarded it as their primary task to further rationalise and automate production work, who identified with the managerial goals of their work and for whom the stubbornness of other workers dealing with their technology was merely a source of disturbance that had to be reduced (Volmerg, Leithäuser & Senghaas-Knobloch, 1986:198–227). Furthermore, engineers tended to advocate for unlimited technical progress and did not consider its potentially unfavourable effects on society (Senghaas-Knobloch & Volmerg, 1990:19–26; Leithäuser, 1999; also Volmerg, 1999).

These historical, mainly Marxist, technology studies have the potential to illuminate the attitudes of tech workers towards technology in digital capitalism as a source of social conflicts because they particularly emphasise the relation of technical workers to technology in regimes of corporate domination. The conceptual framework they are following is what Wright (2015:9–10) theorised as social class orders of exploitation. In this approach, the relation to technology of technical expert workers is seen as structured by their corporate position in organising the activity of other workers on behalf of corporate management, that is, the control of work to increase corporate profits. Empirically it was shown that technical workers are themselves situated on different levels in these orders of exploitation, leading to variations in their work experiences and thus in their attitudes towards technical design.

However, the issue of how tech workers in the digital economy perceive technology and relate to those who use it remains underexplored. Preliminary research that has been conducted into the way that programmers and computer scientists understand the interlink of society and technology has concluded that they mainly follow techno-deterministic worldviews, in which society has to adapt to unstoppable technical progress (Thaa, 2020). But beyond that, no comprehensive research exists on how tech workers relate to their task of reproducing social control over users and workers by developing digital technology.

In order to be applicable to conditions under digital capitalism, such research would need to be updated. Tech workers in the digital economy are significantly different from those engineers researched in historical technology studies, mainly because they are not concerned with organising production for industrial corporations. A new research agenda would need to clarify the function of technology for capitalist enterprises in the digital economy and how it is related to social control in the division of labour and in

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1   Smith also emphasised that the corporate production model – i.e. whether corporations apply Tayloristic mass production or diversified quality production strategies – influenced whether engineers were more dependent on the experience of production workers and thus developed less managerial attitudes towards the design of technology (Smith, 1991).

corporate hierarchies. This question could have several answers. In gig and crowdwork platforms, for example, software engineers might still be concerned with controlling other workers by algorithmically determining and supervising their activity (Rosenblat, 2018; Gandini, 2019; Griesbach et al, 2019; Kellogg, Valentine & Christin, 2020; Herr, 2021). But with the rise of Big Tech and other platform companies which serve as marketplaces, social media and digital app services, new tasks performed by technical workers have emerged. Just as the classical theories of the new middle classes discussed in the previous section illuminated the economic role of engineers in the labour process, contemporary producer studies need to conceptualise the economic functions of these new tasks. Work in the field of political economy of digital capitalism in which Big Tech and platform companies are analysed as economic actors organising markets, controlling consumer access and rationalising distribution (Staab, 2019; Pfeiffer, 2021; Dolata & Schrape, 2023) by establishing surveillance data economies (Zuboff, 2019) could lay a foundation for such research. In such an approach, the digital environments of the platform economy could be understood as data economies, by means of which the tech industry organises market access for other companies by selling privileged information about and visibility for potential consumers – whether this is in search or social media platforms, in app stores or on marketplaces like Temu.

Following the assumptions of this research strand on the political economy of digital capitalism, technical workers in the digital economy do not rationalise the activity of other workers and organise production in corporate labour processes, but design digital tools to rationalise consumer behaviour and organise markets. In other words, their work includes the organisation of the distribution of goods for capitalist corporations. By doing so, they also control the productive activity of users in digital environments, which deliver the data traces used to analyse their behaviour as consumers and thus facilitate market access for capitalist corporations (Beverungen, Böhm & Land, 2015). In particular, conceptual scholarship on what is called surveillance capitalism points to the conclusion that the design of digital tools to analyse behaviour is accompanied by systematic manipulation and steering of users in digital environments to further increase their online engagement and thus their value for selling market access. Hence, it can be understood as a form of corporate control reaching out into the realm of consumer relations (Zuboff, 2019; Voß, 2020). Building on this link to corporate control regimes, the design of digital services can be conceptualised within the framework of Marxist technology studies because tech workers are engaged in organising productive activity for corporate management, but in the realm of distribution rather than production.

Research on new fractions of tech workers developing mass-scaled online services has already started to illuminate this new economic role in the platform and internet industries (Ziegler, 2022; to some extent also Dorschel, 2022b). Which attitudes as producers of those distributive technologies they form and how they relate to the users of their platforms and apps, however, remain open research questions.

Profession studies

Instead of understanding technical expert workers as wage earners affected by economic insecurity and corporate domination or as technical developers reproducing

social inequality, other research strands have conceptualised them as professionals appropriating control of the division of labour and corporate decision-making. Serge Mallet introduced the idea that technical experts in industrial companies form demands for codetermination over company management through their professional interests and thus question the prerogatives of private capital in their corporations. Mallet developed this idea on the basis of three conflict case studies carried out in France in the 1950s, all of them in what were then high technology corporations: *Bull*, a company making electronic calculating machines, *Caltex*, a chemical production site and *Thompson-Houston*, an industrial electronic conglomerate (Mallet, 1975).

In all three companies, he observed an ongoing reduction of manual work as a result of automation and outsourcing, leaving highly qualified technical staff such as development engineers, designers, maintenance technicians and technical draftsmen as the main workforce of the companies. These employees were less interested in conventional claims for higher wages and better working conditions, but more concerned with having a say over corporate decision-making. Beyond that, they were keen to organise collectively and engage in strikes to enforce a higher degree of codetermination on the business strategies of their companies. In a succession of strikes, the engineers of *Caltex* used union representation to control the market strategies of their business management. Because of their technical expertise, they claimed to be better able to decide on production strategies than corporate management. At *Thomson-Houston*, engineers went on strike and urged a move away from household electronics production because they did not consider continued investment in these product lines to be a sustainable market strategy. Moreover, they demanded financial autonomy for the technical departments so that they could decide on budget issues themselves. A similar transformation of interests was observed by Mallet at *Bull*, where younger engineers demanded further training in high technology to realise career progress in the upper technical departments and gain influence in corporate decision-making.

In all three case studies, according to Mallet, professional technical workers engaged in workplace politics which opened up a perspective of worker self-organisation of companies. He assumed that the possession of complex, technical production knowledge changed the interests of workers: instead of focusing on wages and working conditions, they were concerned with the question of what purpose their expertise and the technologies they develop should serve in corporations (Mallet, 1972).

In a similar, but systematic way, power approaches of the *sociology of professions* understand the politics of technical professionals as strategies for appropriating control of corporate and societal division of labour by means of expert knowledge. They assume that professionalism is a way for worker fractions to occupy privileged positions in the division of labour. In pursuit of this goal, professional actors fight competitive battles against other occupational groups and claim monopolised jurisdiction over certain problems in the labour markets and in corporations (Larson, 1977; Abbott, 1988; Freidson, 2004).

According to this approach, in the past engineers as a professional group competed with other occupations, that is worker fractions, that emerged from the organisational requirements of bureaucratic companies, such as accountants or statisticians. All of

these worker fractions were concerned with the management of companies as a problem domain but claimed responsibility for this domain by offering various solutions. Accountants placed knowledge of cost allocation and monetary input-output relationships at the centre of management, whereas engineers brought technical knowledge of production processes and product design into play. With the emergence of scientific management, engineers were initially able to win this conflict over competence, particularly in the USA, because the technical development of production knowledge was seen as a central management criterion for increasing the efficiency of companies. Because many engineers also rose to senior management positions, the profession was able to expand its sphere of influence in organisations and improve its position within labour markets (Abbott, 1988:226–239; also Meiksins, 1996:73). The emergence of new production models at the end of the 1970s, which turned away from strictly technically determined labour processes and instead allowed for more subjective autonomy, on the other hand, promoted competition between engineers and psychologists and personnel managers, who understood the problem domain of corporate management primarily as the integration of stubborn individuals. This development ultimately led to a gradual loss of the elevated position of engineers in industrial companies in the USA (Abbott, 1988:102–105). Hence, in this approach, technical expert workers can be understood as professional actors maximising control over corporate decisions and the societal division of labour. But, in doing so, they systematically exclude other worker fractions from influence over the problem domains they claim ownership of, whether these are accounting employees, psychologists or manual production workers.

The degree of professionalism, that is the monopoly over certain domains in the division of labour, is understood to be determined by controlling the access to labour markets via academic training institutions, professional associations and legal licensing (Larson, 1979:610; Freidson, 2004:47–51). With these mechanisms of social closure, professions as collective labour market actors can exclusively deliver experts for certain domains on labour markets and thereby displace other occupational groups offering their services for certain needs. Engineers realised this 'project of market control and collective social mobility' (Larson, 1979:608f.) historically to varying degrees and, as a result, formed distinctive forms of professional interests. In the USA, Germany and France, engineers first secured their status in the 20th century by establishing formal higher education and legally protected degrees exclusively qualifying them for entrance into upper positions in corporate hierarchies. By this means, they deliberately excluded autodidacts or skilled production workers from higher technical positions. As a result, they were less keen on collective organising and formed elite orientations towards other workers. In Britain, engineers were mainly trained without any formal education in corporate practices and were often recruited from skilled production workers. Their shop floor culture was more oriented towards practical skills than formal or mathematical knowledge. Because of this weakly developed professionalism, they also identified more with other manual workers and were open to union membership (Meiksins & Smith, 1996). In outstanding cases, they even used their technical expertise to support worker-oriented technological innovation as seen in the industrial facility of Lucas Aerospace (Löw-Beer, 1981; Cooley, 2016).

Against this backdrop, professionalism can be seen as a crucial factor for understanding the social conflicts of technical expert workers. Firstly, this is because professionalism means that worker fractions can appropriate the control of the division of labour and decision-making in capitalist corporations. Following Mallet, this carries some potential for workers' self-organisation of companies since expert workers might challenge the prerogatives of private capital. A second reason is that this could also lead to conflicts with other worker fractions because technical experts might compete with other occupations providing expertise for certain domains. Thirdly, in the case of weakly developed professionalism, as was the case for British engineers, the work experiences of technical experts might bring them closer to other workers making them more open to class alliances.

It is apparent that the ways that power is conceptualised in the sociology of professions follow a significantly different approach to that found in Marxist technology studies for understanding technical workers' relation to their products. Professional orientations toward appropriation are seen as dependent on institutionalised mechanisms of social closure by which a certain (technical) profession is securing a privileged position in labour markets. Hence, when understanding their position in social orders of inequality, these accounts focus less on technical workers' roles in organising the activity of other workers in corporate control regimes, and more on how they fight distributive conflicts over market chances against other worker fractions (Wright, 2015:6–7).

So far, no research has been done to investigate tech workers in digital capitalism as professional agents of appropriation. However, such research could open up new potentials for understanding conflicts in the digital economy since the abovementioned new cycle of social conflicts in the digital economy is to a not insignificant extent initiated by tech workers demanding a say in corporate decision-making on the path to digital change. To carry out this kind of research, three aspects would need to be investigated.

First, it would be necessary to investigate how the labour market of tech workers in digital capitalism is shaped and to what extent it is controlled by professional actors in the field of Computer Science, Data Science and other IT-related professions. This would require research on training paths in higher IT education as well as other means of accessing the labour market for tech work, e.g. vocational training, industrial experience, private certificates delivered by Big Tech companies such as Apple or Amazon or just autodidactic education. For instance, some initial research indicates that access to the labour market for data scientists is very heterogenous because professionally controlled, academic training paths are expanded by various industrial certificates offered by Big Tech companies which weaken the control of IT professions over labour market access (Steinhoff, 2022).

Second, research should be carried out on how these different entrance points for tech workers shape their professional biographies and sort them into different positions in the digital economy, in other words how they develop their skills and appropriate domains in the division of labour. For example, university-trained AI engineers with a PhD degree might be more likely to work in the R&D departments of Big Tech companies and use their professionally acquired esoteric knowledge to control

specialised core zones of technical development there. By contrast, less specialised programmers, who have completed a four-week course to learn Python might work in lower technical positions in various start-ups where corporate management might define how their expertise is used.

Third, there is a need for investigation into how tech workers' experiences in developing their expertise shape their professional orientations. Pursuing such a question would involve leaving mere corporate realities behind and investigating the biographical trajectories of individual tech workers, since professionalism is a partly life-long coupling of expertise and professional individuals (Beck & Brater, 1978:139), whereas corporate work realities only include the selective use of those person-bound skills in particular work positions (Beck, Brater & Daheim, 1980:111). Of particular interest when empirically applying approaches from a sociology of professions in such research are the life stories of tech workers in the digital economy. Did they acquire their expertise in elite universities or quick courses offered in community colleges? How did they develop certain professional relations to technical domains? How did they apply these when working for Big Tech companies or founding their own start-ups? And how have they shaped or re-defined their technical expertise when ascending to R&D centres in the digital economy or when becoming disillusioned by multiple bankruptcies and professional re-orientations? These different pathways might shape the professional orientations of tech workers toward technology, understood as their relationship to the pursuit of appropriation or to claims of jurisdiction over the trajectory of digital change.

Conclusion: producer orientation in social conflicts

Within the existing research strands, technical experts in social conflicts can be understood in three roles: as workers affected by economic insecurity and corporate control; as developers of technology reproducing social control over other users; and as professionals seeking appropriate control over corporate decision-making and the division of labour. These different roles can serve as a heuristic framework for categorising contemporary social conflicts which have arisen from the new cycle of tech worker movements since 2017.

Proletarianisation approaches might be able to explain many contemporary conflicts in the digital economy, above all those which are more closely connected to classical union struggles. For instance, following the protest of tech workers, a new wave of union organising has emerged in the USA since the late 2010s. The CWA, traditionally responsible for companies such as AT&T and IBM, kicked off 2020 with the Code CWA campaign to organise workers in Big Tech companies and start-ups. The video games industry, with its long working hours characterised by tight release deadlines, became a focus of organising. In early 2021, the campaign launched the AWU, a minority union at Alphabet/Google. One of their main concerns up to this point was organising temporary workers at Alphabet's data centres, who do tedious, manual work in server farms for $15 an hour. Furthermore, geospatial data specialists

who provided route updates for Google Maps and Content operators for YouTube Music were also supported in unionising to oppose the financially burdensome rollback of remote work regulations. Meanwhile, contract workers training the company's AI models launched a campaign to raise their hourly wages with the help of the AWU. Thus, the Alphabet union became especially attractive to workers among the lower ranks of technical employees who, as temps, vendors and contractors, had to struggle with poor contractual and working conditions.[2] These new organising efforts can be understood as tech workers fighting as workers against proletarianisation, that is against the reduction of wages and the expropriation of control in their working activities. Apparently, new labour conflicts in this field mostly emerge among less privileged groups of tech workers such as outsourced content operators or data specialists.

Initially, however, new tech worker movements were also driven by issues related to the design of technology and corporate control. Some of the approaches adopted in technology and profession studies could be helpful here, as they make it possible to illuminate the attitudes tech workers establish towards technical design and the conflicts they might engage in with regard to appropriate business strategies. As such, these analyses can be understood as genuine approaches to make sense of tech workers as producers of technology in social conflicts and to investigate their producer orientation, that is their attitudes as developers of digital technology. Connecting these two approaches could also grasp two layers of producer orientations of tech workers. Marxist technology studies are more concerned with asking how technical workers relate to the users of their technology as objects of domination – be they other workers in production lines or potential consumers in digital environments. Hence, they focus on these workers' positions in corporate hierarchies, their roles in organising productive activity on behalf of corporate management and the conditions leading them to question their role in stabilising those relations of control. In contrast, profession studies are to a higher degree concerned with the organisation of labour markets and the mechanisms of professional social closure as an influential factor of producer orientations. Hence, they point to an investigation of professional biographies, tracking their development from students learning technical skills in training institutions to professionals applying their expertise in various corporations in order to reconstruct their ambition to appropriate corporate control as workers.

However, these producer theories also have blind spots which might be addressed when updating them for application to digital capitalism and contemporary conflicts over the orientation of digital change in society. As mentioned above, new production and business models of the digital economy are changing the position of technical experts in capitalist corporations and thus also the purposes technology can fulfil for them. This development challenges Marxist technology studies which are mainly concerned with engineers organising the labour process. Beyond that, the approaches of Marxist technology studies and profession studies strictly focus on technical workers' embeddedness in corporate positions and occupational roles as influential factors of

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2   For a complete overview of the actions, see the Code CWA campaign newsletter at: https://code-cwa.org/stories (accessed December 22, 2023), and the summary at: https://www.alphabetworkersunion.org/our-wins (accessed December 22, 2023).

their producer orientations. In doing so, they fail adequately to consider factors such as gender and race, which shape relations to technology and professional orientations but go beyond purely economic realities. For example, contributions in the field of science and technology studies emphasise that software engineers inscribe their own male-entrepreneurial conceptions into time management apps (Wajcman, 2019a, 2019b). Also, work in the field of history of the computer professions indicates that the IT professions were systematically established by systematically excluding women and their perspective, which might have had an influence on professional socialisation processes (Hicks, 2018). Hence, how tech workers are embedded in gendered and racialised conflict lines could affect their design attitudes on technology and their professional orientations. Taking such factors into account when researching the technology politics of tech worker movements could make considerable sense because the domains of their political mobilisation were up to this point to a high degree structured by race and gender issues such as the protests against the cooperation of Big Tech companies with border patrol institutions.

Moreover, as Tarnoff (2020) points out when discussing the mobilisation of tech workers in Big Tech companies, race and gender play an important role in workers' willingness to form collective organisations, because these factors form common spaces of experience, in which tech workers can understand their social position in orders of social inequality. According to him, the protests at Big Tech companies that began in 2017 were largely driven by women and people of colour, partly because they were more affected by workplace discrimination and temporary work, but also because they translated their own experiences of being discriminated against in racially and gender-specific ways in their everyday life to the negative effects of digital technologies on marginalised groups in society. In a similar way, Niebler (2023) describes how solidarity networks of tech workers with gig workers in the platform economy were dependent on common experiences as migrant workers facing similar challenges when arriving in a new society. That is, external social factors of inequality which are not only rooted in workplace realities influence labour conflicts and could thus also shape the attitudes of tech workers as producers of technology as well as their ambitions for an alternative orientation of digital change.

Nevertheless, producer theories still carry the potential to make sense of the contemporary technology politics of tech workers. The domains of their political intervention appear to be very diverse so far – from concerns over policing technology, state surveillance, and racial and gender discrimination to ecological issues. Still, the mobilisation of workers in labour conflicts over technology politics and business models is striking and deserving of further investigation. Crucially, it raises the question, of whether tech workers are not only open to engaging with defensive bread-and-butter-issues, but also to workplace politics concerned with offensively appropriating the digital economy by and for workers.

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