

# THE DIGITALISATION OF WORKING WORLDS: CONCEPTUALISING AND CAPTURING A SYSTEMIC TRANSFORMATION

Brief version<sup>1</sup> of the initial proposal from Oct. 2018 for  
establishing the DFG-Priority Programme 2267

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<b>1 Abstract</b>	<b>2</b>
<b>2 Current state of research</b>	<b>3</b>
2.1 Digitalisation of working worlds as systemic transformation	3
2.2 The digitalisation of the subjects and practices of work	8
2.3 Digitalisation of enterprises and value chains	10
2.4 Digitalisation and the institutions of society and work	12
2.5 Digitalisation of work as systemic transformation: A research agenda	13
<b>3 Programme content</b>	<b>16</b>
3.1 Originality of the project's research questions	18
3.2 Narrowing the guiding research questions	22
<b>4 References</b>	<b>26</b>

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<sup>1</sup> The original proposal also included a coordination concept draft. As the coordination concept is presented in more detail in the current coordination proposal of the PP spokesperson, it is not covered here.

## 1 Abstract

The Priority Programme assumes that the digitalisation of the worlds of work represents a systemic transformation that will change all the institutional systems of working society in a fundamental and lasting way. The programme's intention is to research the digital transformation as an interaction of three process dimensions in which this socio-technical change is: a) socially prepared, b) technically enabled and c) discursively negotiated and socially mastered. At present, research on digitalisation is dispersed among many disciplines and focuses mainly on isolated technical phenomena. The Priority Programme, in contrast, investigates the societal conditions and ways of shaping the current digitalisation of working society as a whole as well as the dynamics and impact of this systemic transformation, which is at once nonsynchronous, interdependent and contradictory. The programme plans to achieve an interdisciplinary combination of social science, economic and historical perspectives on new configurations of work and technology, on multi-layered dynamics of change and on changing forms and places of value creation.

Digitalisation is not yet well understood, neither empirically nor theoretically. For gaining purchase on its phenomena, the Priority Programme investigates systemic transformation as a process that manifests itself in three coincident dynamics: permeating (e.g. of work processes by digital technologies), making available (e.g. of data on individual workers and operations) and perpetuating (e.g. of data-driven value chains). Parallel to this theoretical-conceptual heuristic, the Priority Programme is structured by a second, more empirically oriented heuristic that directs analysis of digital transformation onto three levels: (1) the micro level, in the interplay between the subjects and practices of work with digital artefacts, (2) the meso level, in the interplay of enterprise structures, network structures, value chains and digital systems and (3) the macro level, in the interplay of (work) society's institutional structures and digital infrastructures. In order to ensure programme coherence over two funding phases, individual projects will be grouped into clusters and conferences will be organised thematically following the dynamics-heuristic of digitalisation. Projects and conferences will be supported by a single overarching, theory-focused project.

**Research activities in the *first phase* will pursue the goal of elucidating individual phenomena of digitalisation while also making these results compatible across disciplines, all with the aim of developing in the *second phase* an overarching social and historical analysis of digitalisation as systemic transformation.**

## 2 Current state of research

### 2.1 Digitalisation of working worlds as systemic transformation

For the past several years, new qualities in the way that information technology permeates economic and social spheres—referred to generally as ‘digitalisation’—have spurred much discussion. Digitalisation is thought to carry the germ of fundamental societal change, and far-reaching changes indeed are expected for the organisation of work, as has been discussed as ‘the fourth industrial revolution’ (Schwab 2016; Siepmann 2016) or as ‘Work 4.0’ (BMAS 2016). A heretofore unknown quality of change extending well beyond previous forms of informatisation is expected, due to the multitude and diversity of new digital technologies: big data, artificial intelligence (AI), machine learning, adaptive or collaborative robotics, 3D-printing, and ultimately also comprehensive forms of networking between real and virtual worlds in cyber-physical systems (the internet of things) or through devices worn in or on the body.

Many advocates from the manufacturing industry and industrial policy experts associate these technical developments with optimistic prognoses for industrial competitiveness, promoting them under the term ‘Industry 4.0’ as the wave of the future (agiplan et al. 2015; Kagermann et al. 2013). The Federal Ministry for Education and Research and the Federal Ministry for Economic Affairs and Energy moderate their own platforms dedicated to ‘Industry 4.0’ and ‘Learning Systems’. The platforms are meant to bring together representatives of business, unions and science and to enhance their collective steering capacity. Also, the Federal Ministry of Labour and Social Affairs started a ‘Work 4.0’ discourse on the ramifications of digitalisation for society and industrial policy. Various academic authors, for their part, foresee a new developmental phase of digital or cybernetic capitalism (Buckermann et al. 2017; Nachtwey, Staab 2015), a new opportunity to develop a ‘digital social market economy’ (z.B. Wambach, Müller 2018) or even a fourth epoch in the history of civilisation and media (Baecker 2018). Despite all the ‘Industry 4.0’ hype fogging the discussions of digitalisation, it is clear that all the interlocutors involved—visionaries, doomsayers, supporters and critics—share a common expectation that the permeation of information technology as it exists today will fundamentally change the working world. They share also a common conviction that the precursors of these changes are already clearly in evidence. Against the background of these technological developments and their accompanying social discourses, **the goal of the Priority Programme is to describe empirically the fundamental changes in the working world currently emer-**

**ging in the course of digitalisation, to assess their historical significance and to analyse them with the tools of social science.**

The Priority Programme addresses the question of the extent to which social and technological processes of digitalisation have the character of a systemic transformation and what difference it makes. For us, ‘systemic transformation’ means a multidimensional transformation of work processes on the micro-level of the enterprise, on the meso-level of value chains and economic sectors and finally of the institutional systems of the labour market with consequences for all of the interrelated macro-level societal institutions.

An example: ‘Crowdworking’ alters on the micro-level not just the form of employment (from contractual employment to solo self-employment) but also blurs the boundaries of the work process, estranges labour from the internal relations of firms and subdivides complex, high-skill tasks into a multitude of low-skill routines. At the meso-level, this is associated with the emergence of new business models, such as crowdworking platforms and services like coworking spaces for the newly self-employed. Moreover, crowd-suppliers and the firms that use their services are being conjoined by new, more fluid and global structures of value-creation. At the macro-level, these developments represent a massive challenge to the existing institutions of the working world: co-determination (which is predicated upon enterprise-based employment), the established paths of professional qualification and all those social protection systems tied to beneficiaries’ employment status. Even if crowdwork is unlikely to affect the majority of gainfully employed persons in the near future, the mere existence of this new way of utilising labour power, in combination with the media’s discussion of it, has repercussions also within those working worlds where it is not being used yet.

Within the multitude of highly differentiated working worlds, digitalisation is being accepted, negotiated and given form in very different ways and with varying and interdependent consequences. Thus, the fieldwork for investigating it must be correspondingly differentiated. The objective here is not to illuminate a single process of digitalisation and its consequences for ‘the’ working world from the respective perspectives of different disciplines. Rather, the Priority Programme’s goal is to make the process of digitalisation understandable as a systemic transformation that is multi-layered, contradictory and non-simultaneous (or pluritemporal) Accordingly, the review of the current state of research presented below does not follow disciplinary lines. Instead, it addresses in turn three fundamental issues arising from the digital transformation of the working world. The project understands this to be a process of social and technological transformation that (a) was technically enabled by a wholly new degree of intensity of the permeation of information technology, (b) was socially prepared through confrontations with earlier forms of informatisation

and automation of work and (c) is being socially mastered and given a specific form within enterprises, institutions and ultimately also within the broader segments of society and, at the same time, is being discursively negotiated among actors from industry federations, private enterprises, unions, government, research institutions and the public sphere.

**Technically enabled: a new quality of digitalisation.** In current debates, the terms ‘digitalisation’ and ‘Industry 4.0’ are often used rhetorically for promoting visions of which technologies will be important in the future or for advancing specific research and industrial policy agendas. Nonetheless, as Hirsch-Kreinsen und ten Hompel (2017: 358) correctly assert, there are ‘convincing arguments that a technological advance is currently taking hold with as yet hardly foreseeable structural consequences’. Historians have gone back and forth on the correct historical periodisation of technological progress, e.g. from ‘informatisation’ to ‘computerisation’ to ‘digitalisation’. Initial works classify technological shifts in working worlds chronologically and discuss the question of their ‘newness’ (see Danyel 2012; Hachtmann 2015). From a technical perspective, what is new about the digitalisation of working worlds can be reduced to two basic characteristics: first, a *comprehensive and unbroken digital networking* of all human and machine actors throughout the entire value chain’ and second, ‘the digitalisation and real-time analysis of all information relevant for it’ (Roth 2016: 4) or in other words *the cyber-physical integration* of labour and production processes in space and time together with the digital data associated with them. In this context, Siepmann (2016) underscores five essential innovations in industrial production: (1) the vertical and horizontal integration of enterprises’ internal systems, (2) decentralised intelligence, (3) decentralised control, (4) continuous digital engineering and (5) cyber-physical production systems (see also Bauernhansl et al. 2014). These changes affect not just industrial production. Autonomous systems (AI, machine or ‘deep’ learning) are making inroads into medical diagnostics, finance and insurance (Contractor, Telang 2017; Skilton, Hovsepian 2018). Crowdfunding and crowdsourcing platforms are changing innovation processes (Leimeister, Zogaj 2013; Nagle 2018; Petriglier et al. 2018). Robotics is moving out of the factory into new settings including nursing and other services (Compagna et al. 2011; Decker et al. 2017; Pfannstiel et al. 2017). And buildings and even entire cities are being made ‘smart’ (Meier, Portmann 2016; Morandi et al. 2016). Across all branches and professions, it appears that none of the many worlds of work has remained untouched by the new technologies. The quality of continuous digital networking stands out especially clearly in the area of the so-called platform or gig economy. This

‘uberisation’ (Davis 2015) is made possible by the radical reduction of transaction costs and enables in turn not only the creation of entirely new business models (Langley, Leyshon 2017) but also the emergence of new and precarious forms of solo self-employment (Huws 2017; Kenney, Zysman 2016).

**Socially prepared: the social preconditions of the digital transformation.**

Technical innovations are always socio-technical, and only as such do they have an impact on society (Hirsch-Kreinsen 2018), but social change is inevitably hindered by path dependencies (Hirsch-Kreinsen 2018). Even radical changes are based on gradual transformation processes (Dolata 2011). Historical studies demonstrate this with the case of industrialisation and the sticky question of what constituted the moment of industrial ‘revolution’, to name just one example (see Hahn 2005). For the Priority Programme this means that both the technical and the social preconditions of digital transformation must be investigated together, and indeed they are indistinguishable except through analysis. From a social scientific perspective, changes on the micro-level of the enterprise and on the macro-level of labour market regulation can be interpreted as preconditioning the forms of digitalisation seen today. Social science research on lean-production concepts in the 1990s and 2000s described the systematic standardization of work processes (Springer 1999). Earlier historical predecessors of standardisation (Danyel 2012) laid the foundation for the current use of digital technologies and also for the resulting objectification of knowledge and the entrenchment of new forms of control. These mechanisms are solidifying today into the phenomena of the ‘digital assembly line in the office’ (Boes et al. 2018). The deregulation of labour markets and facilitation of atypical forms of employment (Emmenegger et al. 2012) had already laid the groundwork for a segmentation of labour into core versus peripheral employees (Castel, Dörre 2009), and now the decoupling of work performance from the constraints of time and space is so far advanced that researchers have started to take note of the new forms of stress this creates and to explore new ways of reconciling work and private life (Carstensen 2015; Heiden, Jürgens 2013; Messenger et al. 2017). From the perspective of business management, the 1990s concept of ‘Business Process Reengineering’ (Johansson et al. 1994) laid the groundwork for the current processes of digitalisation. Its core elements were using data and indicators for process optimisation and concentrating on core competencies. On the heels of task-outsourcing and offshoring (Boes, Kämpf 2011) came not only new, network-like structures (Ortmann, Sydow 2001) but also new forms of globally dispersed digitalised work. These were the precursors of crowdwork and the platform economy.

### **Discursively negotiated and socially mastered: how societies process digitalisation.**

In social discourses, new technical developments are often interpreted as game-changing technologies in speculative visions of the future in which their widespread use has changed social reality (for good or bad depending on the author). Indeed, the discourse itself is a predictive factor: it can make a significant contribution to the realisation (or prevention) of these visions, because the imaginability of an alternative future can ignite support or criticism from business, science, politics and the public sphere. This mobilisation can then trigger a process of agenda setting, by which increasingly concrete actions are proposed and agreed upon with the goal of making real (or permanently avoiding) that which was at first imagined (see Borup et al. 2006; Lente, Rip 1998). ‘Industry 4.0’ is in this sense a technological vision with an extremely high potential to change reality (Hirsch-Kreinsen 2016). The multiple Industry 4.0 discourses (Matuschek 2016; Pfeiffer 2017) are neither pure ‘visioneering’ (McCray 2012) done by academics to get funding, nor are they truly participatory processes of technology development like those proposed for technology assessment (Lüder 2014; Simonis 2013). Current discourses are themselves a phenomenon of society’s processing of digitalisation and of interest brokering. Transmitted by the actors involved, these discourses are spreading out from the political arena. They are moving into labour unions, cropping up in the strategic planning of organised interests and finally will have to be implemented concretely at the enterprise level in the processes of technology application and labour management. Incidentally, truly participatory processes that involve real employees (Luo 2017; Totterdill 2017) are as rare as new forms of ‘Co-determination 4.0’ (Haipeter 2018).

Studies of contemporary history are also increasingly relevant for the societal processing of digitalisation. Note especially the potential impact of contemporary histories of the working world that address the pressing issues of today (Andresen et al. 2011; Doering-Manteuffel et al. 2008; Süß, Süß 2011). Firms’ experiences with earlier approaches to automation, as chronicled for example in the case of “Production Hall 54” (Heßler 2014), can help us understand why some visions of Industry 4.0 put such an emphasis on ‘putting the individual in the centre’. Also, knowledge of the historical experience of unions with earlier waves of automation is of central importance for understanding their strategy for dealing with today’s digital transformation of work (Andresen 2014; Hindrichs et al. 2000; Platz 2010; Uhl 2014).

These three dimensions (technically enabled, socially prepared and discursively negotiated and socially mastered) serve to guide the study of digitalisation in the working world as systemic transformation. The full project will integrate smaller

studies on each of the three dimensions into empirically founded, theoretical-conceptual answers to contemporary questions of digitalisation. In doing so, the focus will be on the ties between the three dimensions, accounting for historical patterns and temporalities and illuminating both historical continuities and breaks with the past. Guided by its research questions, the Priority Programme is designed to produce **historically and economically grounded** basic research in the **social sciences** on the digital transformation of the worlds of work, i.e. analysis capable of identifying the underlying process dynamics and emergent structures of the socio-technical transformation at hand, of reconstructing the conditions leading to its appearance and of explaining its effects. The state of the relevant research into current processes of digitalisation can be most accurately described in terms of those three levels of analysis that also make up a core heuristic of the research programme (see 3.2). These are: 1) the digitalisation of the subjects and practices of work, 2) the digitalisation of enterprises and value chains and 3) the digitalisation of the institutions of society and work.

## 2.2 The digitalisation of the subjects and practices of work

In the discourse over the future social effects of the digital transformation on the working world, the prognoses that attract the most public attention are those warning of dire consequences for work and employment, especially **quantitative estimates of the employment effects of digitalisation**. One study that garnered a particularly large amount of attention was published initially in 2013 by Frey and Osborne. They looked at specific employment activities performed by workers and estimated the chances of the activities being eliminated due to computerisation and automation. On the basis of observations of 702 individual professions, the authors concluded that 47 per cent of all jobs in the USA are at high risk of being automated in the next 10 to 20 years (Frey, Osborne 2017). Although studies using a similar methodology predict less dramatic numbers for Germany (Bonin 2015; Dengler, Matthes 2015), a high substitution risk was predicted for some jobs. However, this kind of macro-level, prognosis-generating research reflects poorly the complex interplay at the micro-level between new technologies and employees' concrete tasks, embedded as they are in the context of specific work processes in specific firms (Pfeiffer, Suphan 2018). And indeed, such prognoses have been met with much criticism, especially within the sociology of work. This research tradition emphasizes the central role of firms' strategies and employment policy for shaping the consequences of the roll-out of new technology, and it contests the idea that the relationship between technology, qualifications and employment is deterministic (see Pfeiffer 2018b). Sin-

ce the 1970s, studies have shown that automation has not only a **de-qualifying but also a re-qualifying potential** (Kern, Schumann 1970). Predictions, circulating in the 1960s and 1970s, of mass unemployment due to automation (see Woirol 1996) never materialised. The final break with technological determinism then came in discussions beginning in the late 1980s of new industrial production concepts and ‘lean production’. International comparison showed variation in organisational strategies for implementing new technology, and it became clear that automation does not necessarily represent the most efficient path to higher productivity and quality. Instead, organisation-related factors were seen to have a much more fundamental influence on enterprise productivity (Adler 1992; Jürgens et al. 1993; Sauer 1991).

These discussions continue to influence the sociology of work today. The first available analyses of the digitalisation of work processes (Hirsch-Kreinsen et al. 2018; Huchler, Pfeiffer 2018) underscore the significance of firms’ strategies and actor constellations (Kuhlmann, Schumann 2015). Similarly, Haipeter (2018) examined how the actions of management and works councils and the particularities of their respective production methods shape the use of technologies and its impact on employment. One finding from this research is that due to the conservative behaviour of firms and the incremental nature of change, the organisation of work and structures of employment qualification have hardly changed (Butollo et al. 2018; Hirsch -Kreinsen 2018).

These arguments are not supported, however, by the ‘informatisation’ approach of authors who in the mid-1990s began to analyse firms’ use of computers and the internet (Baukrowitz et al. 2006; Boes et al. 2016; Pfeiffer 2004; Schmiede 2015). Informatisation is understood as a long, historical process of standardisation and objectification of knowledge. These analyses predict increasing digital control over work and the development of a ‘digital assembly line in the office’ (Boes et al. 2018). Recent studies in the tradition of labour process theory argue in a similar vein, emphasising the interest of management in exercising control over the way digital technologies are used in their firms (see Levy 2015; Moore 2018).

The available historical studies support conclusions drawn by the sociology of work. Some studies investigate subjective experiences, perceptions and reactions of employees involved in processes of accelerated technological change (Schemmer 2018). Other studies analyse the stances, reactions and strategies of unions (Andresen 2014; Hindrichs et al. 2000) and the possibility that technological change (automation/digitalisation) can be influenced by trade unions (Platz 2010; Uhl 2014). Other

actors, such as the makers of technology policy, businesses or programmers have yet to attract the attention of historical research.

Investigations in the context of the history of computers have proven relevant for understanding the current transformation process, especially those that look at how computers were first introduced in the working worlds of logistics, administration and banks beginning in the 1950s (see e.g. the special issue with eight contributions edited by Hürlimann et al. 2009; Klenke 2008). They document changes in organisations, work processes and practices as well as early implementation problems and employee opposition. They also clearly show that the introduction of computers was often accompanied by efforts to make data available, to control data and to permeate management processes, all with the intention of managing growth, lowering costs and steering processes more efficiently.

Finally, the sociology of technology has delivered many impulses and challenges for scholars of history and the sociology of work. The concept of ‘sociomateriality’, for example, encapsulates the argument that the relationship between technology and human action is never neutral, nor can it be shaped arbitrarily (Leonardi et al. 2012; Orlikowski, Scott 2008). Accordingly, digital technologies represent a regulatory form through which functional simplification, standardisation, objectification and automation can be realised. In actor-network theory, the agency of technology or of objects is the central motif (cf. Latour 2005). In the German discussion, Schulz-Schaeffer and Rammert argue that work processes must be understood as systems of ‘distributed agency between human and non-human actors’ (2002). These are the characteristic arguments of the sociology of technology. They point to the ways that technology can become self-regulating, i.e. autonomous from human control, and are of fundamental interest for analyses of digitalisation as systemic transformation. Issues related to labour or employment, however, are seldom taken up in studies within the sociology of technology tradition.

### 2.3 Digitalisation of enterprises and value chains

Another group of predictions pertaining to the digital transformation concerns the consequences of digitalisation for enterprises and value chains. Their impetus comes from the new possibilities for the virtual organisation of business ventures due to the increased use of digital networks and the increased prevalence of cyber-psychical integration of value chains. In the social sciences, debates focus on the dangers that arise when firm-based employment relations are supplanted by self-

employed persons performing activities that are transacted on an as-needed basis via the internet. Predecessors are seen in crowdwork and ‘gig’-work platforms (Ben-ner 2015; Schmidt 2017), and the trend is now referred to as ‘uberisation’ (Davis 2015). Given that the lion’s share of labour-market law (employment law, social law, co-determination) regulates firm-based employment only, the eroding importance of enterprise-bound employment—accelerated by digitalisation—raises the fear that we are headed into a phase of extensive *deregulation of employment relations*. Reinforcing these concerns is the fact that the central actors of the platform economy are successfully restructuring the rules of market transactions (see Kirchner, Beyer 2016). The extensive control by a few large internet corporations over new markets (see Dolata 2015), their power to set the transaction rules in them and the concomitant weakening of pre-digital markets and their institutional structures jeopardises employees just as much as the deregulation of employment.

Nonetheless, current research offers no solid affirmation of these negative prognostications. The earliest empirical surveys show that employment in the platform economy is still relatively uncommon, at least in Europe (Leimeister, Zogaj 2013). And there are clear limits to firms’ ability to outsource labour (Krzywdzinski 2018). Noteworthy also is Ford and Honan’s study (2017) of an Indonesian motorcycle taxi platform that served as an impetus for the regulation of a previously unregulated, informal sector.

Economists who study enterprises and value chains interpret the digital transformation as a basic, second-order transformation process, subject to crisis and accruing from many small, gradual steps of a first-order transformation (Burke 2017; Huy, Mintzberg 2003). The top-down character of transformation is underscored, and the language is of systematic, not organic, change (Müller-Stewens, Lechner 2011) with the potential to superannuate the established principles of management and corporate organisation (Choudary 2015). Accordingly, this transformation signifies a shift in the role of management: from the control of resources to the orchestration of resources in networks, from internal process-optimisation to the optimisation of external interactions and from ‘customer value’ to ‘ecosystem value’. Thus, the platform economy implies a serious upheaval in the structure of existing industries and value chains, one that could ultimately dethrone the leading sectors of the economy. This would imply fundamental changes in business models and in the regulation of capital flows (Kenney, Zysman 2016).

At the level of production and logistics, common themes are product individualisation and the autonomy of value chains (Hompel, Henke 2017). The individualisation of products is considered to be one of the central determinants of competitiveness in the current age (Spath 2013), to be realised by increasing the flexibility of production and the autonomy of logistics. This means decoupling logistics processes from specific physical locations, linking all components, production sites and capital flows in digital networks and making use of autonomous transport systems. Logistics systems of this nature should be able to regulate themselves on the basis of microtransactions and in response to new needs. This ‘social networked industry’ (Hompel, Henke 2017) supposedly requires not only new management competencies and concepts but also the formulation of new economic principles. This, however, is the subject of controversy among economists (Henke et al. 2017; Rüeegg-Stürm, Grand 2017; Schuh 2014).

## 2.4 Digitalisation and the institutions of society and work

The possibility that digitalisation will lead to a fundamental transformation of society’s institutions and regulatory systems is now widely discussed. A number of historical studies underscore the formative effect of such discourses and societal processes of negotiation on the way in which technology is used (Heßler 2014, 2015a,b; Schwarz 2015; Uhl 2014). The vicissitudes of the recent digitalisation discourse have already been the subject of social scientific analysis (Matuschek 2016; Reischauer 2018; Wilkesmann, Wilkesmann 2018). Pfeiffer (2017) shows that the discourse is not merely a reaction to technological innovation but is in fact being initiated and promoted by transnational actors and national interest groups with a link between technology and industrial policy and labour market deregulation.

Currently it appears that the platform economy in particular is undermining employment law and social welfare regulations by creating an employment sector untouched by the social welfare system, where labour law and rights such as the freedom of association and co-determination are invalid. This applies also to Germany (see e.g. Hanau et al. 2018). Nachtwey und Staab (2015) weave a number of these developments into a *diagnosis of digital capitalism* (see also Staab 2016) characterised by the market dominance of internet companies, the appearance of new forms of control over work processes (‘digital Taylorism’), deregulation due to labour outsourcing and finally by *work-on-demand* as a new type of employment.

Such diagnoses of a digital transformation of the working world are not yet supported by strong empirical evidence. The quantitative effects of the digital transformation on employment are open for debate, as are estimates of the significance and growth dynamics of the platform economy. Also, it cannot be said for sure that the activation of work via platforms will necessarily lead to a deregulation of work. Indeed, those prognosticators who focus on the disruptive potential of digitalisation might seriously underestimate the staying power of existing institutional structures and historical path dependencies (Hirsch-Kreinsen 2018). In sum, all these assertions and prognoses regarding how the digital transformation of the working world will progress are in fact better suited for describing future research questions than for answering them.

## 2.5 Digitalisation of work as systemic transformation: A research agenda

The interdisciplinary literature review above suggests the following desiderata for a research agenda intended to advance a theoretically grounded, social science analysis of the digital transformation of working worlds.

*First*, the empirical analysis of transformation processes is to be continued and systemised *within* the three levels of analysis: work processes (micro), enterprises and value chains (meso) and institutional systems (macro). The new qualities of current digitalisation phenomena—in comparison to historical precedents in information technology—must be explained more precisely, particularly in light of the interplay between social actors, enterprise structures and social frameworks. All analyses assess also the historical significance of these developments.

*Second*, it is necessary to investigate connections *across* these levels of analysis in order to better specify the systemic qualities of transformation processes. In doing so, social science and historical approaches must be integrated for comparing the current situation with historical patterns from the 1970s onwards and for differentiating historical continuities and breaks across micro, meso and macro levels. Such historical studies, focused on social processes of negotiation and adjustment to recent technological advances in the working world, hold great promise for filling knowledge gaps and moving the digitalisation discourse forward.

*Third*, it is necessary to find a common language for the multitude of disciplinary concepts and theoretical grammars relevant to digitalisation. For example, historians most commonly operate with the idea of a structural break in the historical continuum, which they see as having occurred in the 1970s, but the relationship of ‘structu-

ral breaks' to a concept of systemic transformation ought to be clarified. Economic approaches address current digitalisation processes using the concepts of individualisation and autonomy, but they have yet to look into possible forms of interdependence with social institutions and actors. Finally, the areas where the sociology of work and the sociology of technology intersect in ways relevant to digitalisation need to be elaborated so that their contributions can inform wider interdisciplinary analyses.

Addressing the desiderata in the current research is the central task for the Priority Programme. By working through the three individual desiderata noted above, the driving question of the programme is to be answered, empirically elucidated and analytically understood: How is the digital transformation currently being socially prepared, technically enabled and, finally, discursively negotiated and socially mastered? However, reaching a satisfactory answer requires more than just commissioning separate studies to fill gaps in the literature. Instead, the Priority Programme orchestrates efforts onto the most important and challenging desideratum, the **development of a concept of digitalisation as a systemic transformation**. This is to be accomplished within an interdisciplinary and economically and historically informed social science context.

Previous systemic social critiques relevant to the phenomena of digitalisation have been fruitful, but they have been weakened by empirical developments. Touraine (1985) und Bell (1999) started a discussion in the late 1960s on the possible effects of a fundamental transformation in economics, work and society in connection with digital technologies. Later, Castells (2000) and Bauman and Lyon (2013) re-enter this topography. The link between technical change and work in society also has been discussed in German social science, but not in earnest since the 1980s, when it was a prominent topic in the meetings of the German Sociological Association (Dahrendorf 1983; Lutz 1987). Since then, there have been very few systematic attempts to understand socio-technical transformation processes in terms of broad historical and social dimensions. Moreover, gender relations and female-dominated working worlds were not addressed in the early debates on automatisisation, nor are they being addressed in current debates on digitalisation (Kutzner 2018; Wajcman 2010). Contemporary critiques, some coming from popular science, prognosticate utopian or dystopian social developments under the assumption that gainful employment will all but disappear (Brynjolfson, McAfee 2014; Mason 2016; Precht 2018; Rifkin 2014), but they hardly concern themselves with an empirical or theoretical grounding of how society is processing the challenges of digitalisation. These are mostly conceptualized as exogenous to society.

Whether social theory approaches such as ‘annexation theory’ (Dörre 2012) or Polanyi’s early analysis of the first industrialisation in *The Great Transformation* (2002) are applicable to the current digital transformation has yet to be demonstrated. Historians are generally sceptical, and some argue explicitly that previous approaches are in no way applicable (e.g. Osterhammel 2015). Moreover, Polanyi’s core concept of ‘embeddedness’ has itself undergone a transformation, as argued by Beckert (2007). More recent historical studies note a ‘structural break’ of revolutionary proportions stemming from the 1970s and 1980s (Doering-Manteuffel et al. 2008). In Reißig’s (2009) recently developed concept of social transformation, it is interpreted as being formed by various social actors but also as self-reinforcing and organic-evolutionary. Modernisation theory, with its considerations of a reflexive ‘second’ modernity and the all-important side-effect theorem (Beck, Lau 2004), offers a way to understand the limits of society’s capacity to process digitalisation, but it lacks an association with socio-technical change. Only social science, economic and historical perspectives lend themselves to an interdisciplinary formulation of the transformation concept. Potential conceptual bridges already exist, e.g. for subjectification processes (Doering-Manteuffel et al. 2008) or for the historical contextualisation of social science studies of the world of work (vgl. Neuheiser 2013). These are documented, among other works, in the edited volume of Andresen et al. (2011) that addresses the theme of structural break.

Institutionalist approaches (cf. Streeck 2009; Streeck, Thelen 2005) investigate various dynamics of change that are relatable to digitalisation and have thus struck a chord in debates in the sociology of technology (Dolata 2011). However, because of their particular disciplinary focus, these approaches address a limited segment of society and do not take the diversity of working worlds into consideration. Noteworthy is Cortada’s (2003) somewhat controversial attempt at a synthetic analysis of the impact of digitalisation for different economic sectors in the USA.

These strands of debate and theory are useful as points of departure for the work planned for the Priority Programme. Yet these theories lack instruments for capturing the particular socio-technical character of contemporary digitalisation and thus for analysing the interconnectedness of and the interplay between technology and society. The social critiques noted above offer no full elaboration of a) an acknowledgement, compatible with the sociology of technology, of technology’s materiality and its independent impact on society, b) a connection to economic constellations that is consistent with economic theories, c) an historical periodisation of diagnosed or prognosticated developments and d) the analytical level encompassing all the respective

social practices and concrete coping strategies. Thus, the positioning of the Priority Programme within existing social theory is undetermined at the outset. Instead, the Programme will use interdisciplinary analysis of core transformation mechanisms to lay the groundwork for a new, interdisciplinary understanding of the digitalisation of working worlds as systemic transformation.

### 3 Programme content

All social critiques of digitalisation in the working world make the argument that the world is witnessing a process of change that cannot be described adequately using conventional categories of technical and social transformation *within* relatively stable institutional systems. The state of current research underscores the need for a systematic and interdisciplinary approach to clarify the concepts and terms needed for capturing the essentials of the transformation. This is the central objective of this research programme, which is designed to produce **economically and historically informed basic research in the social sciences** on the digital transformation of the worlds of work.

The analyses to be undertaken within the Priority Programme will be directed to the underlying dynamics and structural innovation processes of digital change: identifying them, reconstructing the preconditions of their emergence and explaining their effects. A main goal of the investigations will be to determine the extent to which digitalisation can be understood as a **systemic transformation**. Thus, transformation concepts will be drawn upon for laying down the conceptual foundation of the Priority Programme. Its empirical focus will be on all forms of gainful employment because of the central role that institutional systems of employment play in modern society.

The research programme investigates the dynamics of change in working worlds, guided by a theoretically open heuristic intended to enable interdisciplinary cooperation between the social sciences, economics and history. This specific disciplinary combination will serve to augment the historical underpinnings of the current discourse, which has been focused to a fault on current trends and on prognoses of future developments. For this reason, the Priority Programme will analyse the digital transformation as arising out of the conjunction of **three digital transformation dimensions**, or in other words the conjunction of processes through which socio-technical change is a) **socially prepared**, b) **technically enabled** and c) **discursively negotiated and socially mastered**. What are the contours of these three dimensions of the digital transformation? What are their relevant historical contexts?

How are they being regulated (or evading regulation) by actors and institutions? These questions guide the studies to be conducted within the Priority Programme.

Much of the existing literature can be divided into two camps. One camp is motivated primarily by questions of practical application, looking at empirical developments in specific fields under the assumption that technology-driven changes are already here. The other camp is more ambitious in scope and works toward broad social critiques. With an eye on the big picture of digital transformation, these are often essay-like in style and not strong on empirical evidence. Both camps show tendencies to either underestimate or overestimate the newness of phenomena being observed and to offer one-sided interpretations of their potential effects (positive as well as negative). In contrast, this Priority Programme takes a **basic science approach**. It will produce analysis, not prognosis. It seeks an understanding of the developmental dynamics of the digital transformation in their respective historical and social contexts.

The research programme employs the following **two analytical heuristics** for pursuing the two complementary goals of empirically describing and the theoretically conceptualising the digitalisation of working worlds as a systemic transformation.

Its **theoretical and conceptual heuristic** consists in the differentiation between *permeation, making available* and *self-perpetuation* as the three central developmental dynamics in the digital transformation. Note that these three dynamics can be mutually reinforcing or mutually contradictory, depending on time and context. This heuristic is one of the central elements contributing to the originality of the research programme (see 3.1) because it will help establish an understanding of digitalisation as a systemic transformation, independently of any one specific disciplinary approach. It also enables cross-communication between the individual empirical projects of the programme, which are to be designed and implemented from the perspective of specific disciplines.

Its **empirical heuristic** prescribes a differentiation between the *micro level* of the interaction between the subjects and practices of work with digital artefacts, the *meso level* of the interaction of firms' organisational and network structures with digital systems and the *macro level* of the interaction between the institutions of society and work with digital infrastructures. It includes also an evaluation of the *temporalities* of change. This heuristic frames and guides the programme's effort to generate valid empirical descriptions of the various worlds of work and also serves to define the limits of the programme's subject matter.

The current form of digitalisation in the working world, with all its weighty ramifications, is an ‘emerging field’ for social scientists and historians, having purportedly wholly new qualities that present major challenges for existing business practices, employment structures and the economy generally. It does indeed have the potential to transform the institutional framework of employment and could thus very well have wide-ranging effects on society as a whole. Although those disruptive, revolutionary and exponential transformations so often invoked in the discourse on digitalisation should be viewed with a grain of salt, it is nonetheless certain that we will see complex, contradictory and nonsynchronous processes of change and disparate developments in various working worlds. All this is likely to be very different from any transformation yet experienced in the post-war era. For this reason, the Priority Programme will work towards the **integration of social science, economics and historical perspectives** in order to make an original contribution to the analysis of the current transformation. Its primary goal is the development of an understanding of digitalisation—grounded in history, economics and social science—as a systemic transformation of the working world. Its second goal involves the theoretical-conceptual work of adapting various concepts and theories from separate disciplines into a mutually compatible set. These two goals, guided by with the analytical heuristics noted above, constitute that which makes the Programme’s research questions original, delimit its subject matter and help ensure the coherence of all the planned outputs.

### 3.1 Originality of the project’s research questions

The starting point of the Priority Programme is the thesis that the digital transformation of working worlds can be characterised comprehensively by three general dynamics: *permeation*, *making available* and *self-perpetuation*. This analytical triad, described in detail below, is meant to take into account the multi-dimensionality of what is assumed to be a systemic transformation process and to support analysis of the historical-social precursors and contexts of the current socio-technical transformation. Additionally, this heuristic offers conceptual docking points for participating disciplines within social science, history and economics.

*First*, we observe a new quality of data-driven permeation of social reality. Technologies are creating new forms of digital accessibility (in heretofore unheard of levels of intensity) to social processes, to individuals and to individuals’ actions. New forms of accessibility are now so ubiquitous that some kinds of non-digital forms of social interaction are becoming increasingly difficult. They are threatening to virtualize all the ways in which society forms its prejudices and opens up or closes down oppor-

tunities. In the working world, the permeation of information technology is accompanied by an increasing transparency of business and work processes. All this expected to take concrete form on different levels:

(a) The mastery of data and data analysis using digital infrastructure will become a central element of (data-based) business models and threatens to replace practical knowledge, supervisory functions and expert professions.

(b) The entire value chain will be digitally permeated such that customers, businesses, suppliers and service providers are networked in real time. Starting with the customer's order, all steps and thus also all work processes will be systemically networked and transparent. Employees, factories and even individual parts and components will exchange information via digital infrastructures and thus become integrated into decentralised, self-regulating systems.

(c) Specific activities and even the individual worker (no longer just workers' labour capacity and performance) will be permeated by digital technologies. Every single step in the work process, including intellectual work processes, will be transparent and subject to control. The metadata necessary for robotics and the vital-sign data gathered by wearables make possible, especially through the creation of and comparison to performance standards, a new degree of access to the bodies and behaviours of individuals at work.

*Second*, these forms of permeation are accompanied by new ways of *making available*. As we use it, this term embraces the ever-increasing forms and means of accessibility (approach, appropriation, transparency, control) to an ever-growing set of resources (infrastructures, information, things, labour capacity). The *accessibility of informational resources* had already begun to increase in leaps and bounds once digital conversion made it increasingly easier to overcome the physical gaps blocking the exchange of knowledge stored on different media. More recently, accessibility has increased also due to the creation of data incidentally to activities performed through digital media (metadata, data shadows) and due to the increasingly dense networking of active-sensor components distributed throughout the physical environment. It is becoming ever more readily possible to perform work tasks through digital infrastructure and to create and assign discrete tasks as digital work orders. This makes it increasingly easier to decouple labour from the place of business as a place of economic production and social inclusion. In the platform economy, corporations are taking advantage of new opportunities for dividing and coordinating labour that al-

low them to overcome conventions rooted in older forms of labour organisation (and labour regulation). New forms and means of providing digital and human resources are arising, including:

- (a) new digital infrastructures (internet of things, the cloud, mobile devices, distributed ledgers);
- (b) new troves of digital data constantly being generated by devices and individuals in enormous amounts that are ever-more commonly being analysed (big data analytics) and used to generate predictions (predictive analytics, machine learning); and
- (c) individuals who place themselves at the disposal of an external agent for the performance of tasks on demand, e.g. through crowdwork platforms.

*Third*, processes of self-perpetuation with wholly new qualities are emerging. Dynamics of scalability and acceleration (especially in the platform economy) are common, but even more important is the extent to which human tasks are being delegated to technology (autonomous machine-learning algorithms that make selection, optimization and problem-solving decisions). The momentousness of self-perpetuation processes is particularly evident in the use of machine learning and artificial intelligence. These are already being used for hiring decisions and diagnostics in diverse fields of application ranging from hospitals to industrial plant maintenance. These developments are emerging on different levels:

- (a) on the level of algorithms that are not transparent either because they are kept secret deliberately or because they are the unfathomable product of machine learning;
- (b) on the level of networked cyber-physical systems in which humans, plant equipment, materials and parts interact, insofar as these systems can regulate themselves and carry out micro-transactions autonomously.

For a complete understanding of the digital transformation, it is crucial to avoid representing these three dynamics as being driven by technology alone. They are discursively negotiated and socially mastered in the constant interaction between the opportunities and limits created by technology and society. And these processes are in no way linear. They are processes fraught with diverse and new digitalisation-specific contradictions and mutually opposed dynamics, as seen for example in the opposition between the *impetus to regulate* and the *limits on regulation*. New socio-techni-

cal constellations and their consequences make new forms of social regulation necessary, yet society's regulatory capacity is simultaneously limited by newly emerging barriers such as those set by pre-existing socio-technical regimes. Similar contradictions are seen also in the opposition between *decoupling* and *increased interdependence*: digitalisation may lead to the unhinging of institutional certainties (e.g. employment contracts being replaced by crowdwork), but it also creates new forms of dependency (digital path dependencies, more complex and more vulnerable infrastructures).

Permeation, making available and self-perpetuation do not proceed smoothly. They are, instead, highly discontinuous developments that may sometimes undermine, sometimes intensify pre-existing economic and societal interests, social inequalities and established relations of power, gender and domination. They always tend to escape the grasp of society's regulatory capacity. On the one hand, each of these three dynamics can be self-contradictory in its own right. For example, when processes of making available are bundled by just a few actors (Google, Facebook etc.), transparency may increase on some levels but this can also lead to an intensification of old inequalities and prejudices and to the creation of new ones. On the other hand, all three dynamics can have mutually reinforcing and contradictory effects simultaneously. Permeation, for example, can serve to increase knowledge (e.g. of the behaviour of by self-driving cars), but self-perpetuation has the opposite effect (e.g. when the decision logic of autonomous systems is unfathomable).

The heuristic of the three dynamics of permeation, making available and self-perpetuation is the analytical toolset of the research programme. They lay bare contradictions and the wholly new challenges to society's self-regulatory capacity associated with them. Of central importance, however, is the fact that the processes of permeation, making available and self-perpetuation are currently disrupting in some way or another virtually all dimensions of work. They are changing labour markets, business structures, business processes, value chains and labour processes and tasks. They are altering the accessibility to individuals in work relations, as they work, in their decisions to engage in certain tasks and in the interface between their professional and private lives. They represent a challenge to all the institutions of the labour market: the business enterprise (as a socially constructed workplace); industrial relations and co-determination; occupational safety and systems of vocational qualification; and finally also working conditions and compensation, all the social security benefits tied to gainful employment and all the processes of socialisation and social inclusion that are realised in the employment context. Yet, these three dy-

namics cannot be understood without looking at long-term historical processes (cf. Beninger 1986). The confrontation between historical perspectives and the recent diagnoses coming out of social science and economics thus promises crucial insight into contemporary problems. An interdisciplinary and basic-science research approach to a dynamic and multi-dimensional transformation requires a stringent and coherent work plan, and the programme's strategy for approaching its subject matter (the second analytical heuristic) is explained below.

### 3.2 Narrowing the guiding research questions

The subject matter for study are the phenomena of the current digital transformation with all their preconditions, process dimensions and implications in the context of gainful employment within the diverse set of specific working worlds and all their related institutional frameworks. The analytic heuristic of the three dynamics is to be complemented by an operative analytic that is useful across disciplines. Following its guidelines, all of the research conducted in the programme will consider also the interplay between analog and digital technologies, in the past and present. Of interest are parallel chronologies, internal logics and contradictions in earlier (from historical perspective) and contemporary (from social science and economic perspectives) stages of the digital transformation. Establishing common ground among these disciplines will help put the colourful rhetoric of digitalisation into perspective and prepare the ground for a deeper understanding of the social transformation processes involved.

Finding common ground is the central purpose of the second of the two above-mentioned analytic heuristics, namely the differentiation between micro, meso and macro levels with an integrated consideration of temporalities. Following the analytical convention in social science and history, the social micro level consists of the social processes and structures that emerge through the direct interaction between subjects and the respective circumstances of the situations in which they act. The meso level consists of social processes and structures of organised collective action in firms, associations, state organisation, etc. And the social macro level represents the society as a conglomerate of mutually related fields of action insofar as they are relevant to the whole, e.g. the economy, politics, science and the media. For a basic-science oriented analysis of the digital transformation of working worlds, these three levels of analysis are to be specified more narrowly, as explained below.

At the **micro level**, investigations concentrate on **transformation processes in the interplay between the subjects and practices of work with digital artefacts**.

The subjects of work come into focus in their different positions and roles, such as technology developers, as industrial and service workers using new technologies or as workers in unconventional employment situations (solo self-employed in the crowd or platform economy). A central question is how the subjects of work interact with digital technologies (also in contrast to their interactions with pre-digital technologies) and make them their own. Also to be investigated is how the processes of increasing permeation, making available and self-perpetuation alter the set of actions available to the subjects of work. A large number of technological developments are relevant in this context as ‘artefacts’, including algorithms, networked systems, robots, wearable devices like data glasses or ‘smart’ textiles. These all have varying effects on work practices and on the labour capacity of work subjects.

Investigations on the **meso level** concentrate on **transformation processes in the interplay of enterprise structures, network structures and digital systems**. Of

central importance is the structuring or restructuring of work processes, production processes, business models and value chains through new digital technology and its management (e.g. platform architecture, networked and cyber-physical systems, blockchains and digital ledgers). The focus will be on the organised actors and actor groups who influence these changes. The goal is to analyse processes by which the emerging structures of digitalisation are being negotiated both within and outside of business enterprises. This includes historical processes such as the introduction of service automation or CIM. Of equal importance are questions of how new technologies are created and disseminated, from their birthplace (such as laboratories and other spaces of experimentation and learning) to industrial strategies (including those of venture capital in Silicon Valley or traditional industrial enterprises in Germany).

The **macro level** perspective examines **transformation processes in the interplay of (work) society’s institutional structures and digital infrastructures** and

focuses on new global network and spatial formations. The goal is to identify the (technical, discursive and social) motors of digitalisation in society and to achieve a better understanding of the institutional framing conditions for the digitalisation process as they are being continually modified in interaction with digitalisation-induced changes in the technological foundations of social production and reproduction. Of central importance are the dynamics of the institutionalisation (or the de-institutionalisation or re-institutionalisation) of employment situations and the la-

bour market as well as the attending transformation of social and (post-)industrial structures and the emergence of new social inequalities or disparate participation opportunities. Important at this level of analysis is international comparison: of national production and welfare models and of new transnational configurations of power and domination.

On all three levels of analysis, **temporalities** and social-process dynamics are to be carefully considered. The relationships between historical continuity and change will be analysed, including investigations of earlier technology discourses and governance forms in comparison with current transformation processes in the digital worlds of work.

Whilst current discourses emphasise the disruptions caused by digital transformation (see section 2), historical research points to long-term predecessors with multi-layered temporal qualities and parallel-running continuities and discontinuities. They point also to the social meaning of discourses that revolve about future developments. The **historically informed assessment** of the supposedly new phenomena of digital transformation (and of their perception by society) will be undertaken by the Priority Programme systematically on all three levels of analysis.

If the thesis is correct that the current socio-technical transformation of the working world possesses the quality of a systemic transformation, then it follows that the transformation is occurring on all three levels (micro, meso, macro) simultaneously (albeit with different temporalities) and thus that it cannot be fully comprehended by looking at any single level alone. At the same time, studies that attempt to take in all aspects of the transformation at once will produce, at best, social criticism supported by some empirical evidence for face validity. It will not produce an empirically grounded analysis of the transformation. For reaching the goal of a basic-science oriented social analysis of digital transformation, a systematic and step-wise division of labour is necessary. The Priority Programme accomplishes this across two funding phases (2 times 3 years), explained as follows.

The **first funding phase** involves the identification and empirical investigation of the specific structures, processes and mechanisms in which a systemic transformation of the working world manifests itself. The structure of each individual project is framed by the **empirical heuristic of the three levels of analysis**. In this phase, individual projects focus on aspects of digital transformation that can be said to take place in the main as either micro, or meso or macro level social processes of the working world—including historical precedents and currently visible asynchroni-

ties. This will help ensure that research efforts are kept sufficiently close to the individual phenomena of digital transformation so as to allow the generation of empirically grounded analyses. Initially from the perspective of individual disciplines and then in interdisciplinary exchange toward the end of the first funding phase, conclusions from individual projects will be interpreted using the dynamics heuristic. This will help ensure a smooth conceptual-systematic transition to the second funding phase.

In the **second funding phase**, findings from individual programme projects will be analysed more intensively in combination with one another, with the goal of gaining a deeper understanding of the overarching context of transformation. Cross-referencing between studies and especially between different disciplines will be eased by the **theoretical-conceptual heuristic of the three dynamics** of permeation, making available and self-perpetuation. The main focus of this funding phase will be on delineating the systemic character of the digital transformation of the working world, whether in individual projects or through interdisciplinary cooperation across projects. Empirical findings will flow even more systematically into interdisciplinary conceptual work in the second funding phase. Efforts will be directed toward describing the social-technical transformation in its entirety and—by employing the methods of social science, economics and history—toward clarifying how and under what conditions and with what implications this transformation is socially prepared, technically enabled and, finally, discursively negotiated and socially mastered.

The broad **thematic focus** of the Priority Programme applies equally to each individual project and serves as the selection criteria for project proposals. Funding will be made available only to projects seeking to make a **basic-science oriented contribution from the perspective of social science, economics or history to the investigation of socio-technical change**. Individual proposals from the disciplines of sociology, economics and history are especially welcome, but other social science disciplines that relate to the working world are also of interest (e.g. political science, human factors and ergonomics, industrial and organisational psychology, economic geography, business informatics and occupational training research).

The subject matter of individual projects should be limited to working worlds related to employment, including new forms of self-employed paid work. As we define it, this includes any activity done for gainful employment, including for example new forms of platform-organised solo self-employment or work in the digital shadow economy. However, female-dominated worlds of work that have been neglected by conventional research into automation may also be investigated, including for ex-

ample nursing or secretarial work. Individual projects may focus on those **forms of digitalisation currently being discussed as 'new'** but may also look at older phenomena of automation and computerisation. In both cases, it is important to make connections between earlier and current developments. Historical analyses extending to the 1950s are appropriate.

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