# 8 CONCLUSION

The theme of the digital and digitalization dominates this book, as signaled by the title. The notion of digitalization has entered everyday vocabulary in unprecedented ways, thus punctuating the normally all-too-effective separation of academic from public discourse. Fear and awe are evoked in equal measure in the public media covering all spheres of everyday life, be it in your home with AI working as "your own butler" (D. Brown 2021) to perform chores, at work where "robots are coming" (Deming 2020), in places caring for the elderly with chatbots (Mateescu and Eubanks 2021), or in museums featuring artificial intelligence (AI)–based artists (M. Brown 2021). This ongoing public debate demonstrates, at a minimum, how digitalization is experienced as present and relevant in ways it has not always been. In this sense the digital is experienced as phenomenologically real in our everyday lifeworld (Boellstorff 2016). Coined decades ago by cultural theorists, digitalization is *domesticated* into the moral economy of everyday life (Silverstone and Hirsch 1994).

The broad interest into digitalization, however, comes with an ambiguity: the discourses, spanning from the public to academic, are made possible because of, not despite, ambiguity or underspecification of the concept (Swanson and Ramiller 1997). This motivates a principal concern of this book: What *is* digitalization and what does it *entail*? Against the backdrop of practices of knowing in the Industrial Internet of Things (IoT), what is the emerging picture of digitalization, and what are the contours of digitalization offered?

In this book, digitalization is conceptualized as *efforts to quantify the qualitative*. There are important caveats that need to be addressed, however, before we get into what such a perspective amounts to.

First, the qualifier "efforts" (of quantification) is essential. As demonstrated in the empirical chapters of part II of this book, the efforts to quantify are precisely that, efforts. Quantification may well be the ambition, but its realization is littered with setbacks, resistance, infrastructural work, or outright dismissal. Hence, the resulting level and type of digitalization is an amalgam of the arc of the ambition with counterreactions.

Second, efforts to quantify, clearly, are not new. On the contrary, historic accounts of processes of quantification analyze the emergence of modernity and its institutions through this lens (Crosby 1997; Espeland and Stevens 1998; Igo 2007; Merry 2009; Porter 1996). For instance, Didier (2020) gives a rich, historic analysis of the collective, distributed, and heterogeneous practices—recruiting statisticians, editing and commenting on questionnaires returned from respondents, refining mathematical notions of random sampling and sample frames—involved in crafting a unified measure of (among other things) agricultural yields in America in the 1930s around the time of the Great Depression. In his analysis, quantification allowed a grasp of "America as a whole," a qualitative phenomenon that was instrumental for governmental interventions (policies) and the welfare state. Thus, it is not the novelty but the versatility (Kallinikos et al. 2013; Zittrain 2006; Yoo et al. 2010; see chapter 6), resulting in expansion in scope and reach, that characterizes digitalization qua quantification. In what follows I discuss the emergent picture of digitalization through the three dimensions of this book outlined in chapter 1, the objects, modes, and machineries of knowing.

## OBJECTS OF KNOWING: PHENOMENOLOGICAL REAL

Understanding digitalization qua quantification implies pursuing Boellstorff's (2016) call to understand how the digital can be real by tracing out how the "real" physical objects that intentionally oriented, purposeful work practices are directed toward are rendered digitally. Part II of this book provides empirical detail—across real physical objects such as oil reservoirs in geological formations below the seabed, sand particles gushing through pipelines of extracted hydrocarbons, and fish, mammals, and corals as part of the Arctic marine environment—of the processes that go into making

digital renderings meaningful and consequential. Collectively, the empirical accounts in part II portray how IoT data feeds increasingly conjure up the phenomenological lifeworld in organizationally meaningful ways; that the digital representations and algorithmic phenomenon are organizationally real. This is in part tied to the increasing richness or scope of sensors' ability (or rather, attempts) to quantify qualitative, tactile experiences, including smell, taste, temperature, and visual perception (Singh et al. 2014). In addition, the real-time and interactivity characteristics add to the realism of the digital, as suggested by the notion of nowcasting (Constantiou and Kallinikos 2015). As Knorr Cetina (2009) notes, the real-time tickers of traders in her case create a fluid reality, a synthetic situation in which the digital representations (ticker feeds) are perceived as real because "as the [real-time] information scrolls down the screens and is replaced by new information, a new market situation—a new reality—continually projects itself" (72).

Again, these processes of quantifying qualitative objects need to be understood as efforts or attempts at quantification, not accomplishments. A helpful way to unpack the tensions and trade-offs implicated in these efforts is through Latour's (1999) notion of a *circulating reference*. The notion is illustrated by an ethnographic study of a team of life scientists targeting the qualitative, physical object of a particular section of the Amazon forest in Boa Vista, Brazil. They are tasked with determining whether the savanna is retreating or expanding in this area of the Amazon forest, a question no different in character from that in chapter 7 regarding potential disturbances to the Arctic marine environment. In Latour's account, the scientists go about answering the question through a sequence of translations quantifying aspects of the originating qualitative phenomenon. The undifferentiated forest is partitioned into a grid of equal-sized squares, which is one-to-one mapped and miniaturized to the scale of a small box divided into the same grid pattern. Physical samples from the gridded forest fill corresponding cells in the miniature, known as a *pedocomparator*. The samples are subsequently quantified by measures of color (using the Mansell code) and composition. There are, in the context of this book, two salient aspects of Latour's analysis.

First, the successive steps of quantification outlined above are not about replacing or substituting the qualitative for quantified renderings,

but translating. The forest is not the same as the miniature box mapping it, but for the purpose of answering their question about whether the savanna is retreating, it may fill a productive role. This is similar, for instance, to Prentice (2013), who studied surgeons. For the particular purpose of teaching surgical procedures, she found that the embodied, tactile knowledge work of surgeons could be replaced by digitally rendered substitutes in which "[real-time] graphics [of surgery] replace the sense of 'hands-on'" (83). This is exactly the point emphasized in this book when, for instance, digital renderings of sand (sensor measurements, plotted trends, predictive algorithms; see chapter 6), for the purpose of sand-monitoring routines, fill the role of physical sand. Tying back to Boellstorff's (2016) call for understanding the realness of the digital, then, amounts to analyzing the conditions and purposes, be it a retreating versus expanding Amazon forest, the search for oil reservoirs in geological formations, or the study of the biomass in the Arctic, for practically useful translations of quantified/ digital representations. It is, in other words, an epistemic concern for conditions for performing tasks rather than an ontological concern for what these representations "really" are.

Second, and building on that above, the translations/steps of quantifications are motivated by pragmatic concerns or trade-offs: the translations are symmetric in the sense that you gain something but simultaneously lose something. Relative to purpose, the translations are helpful and therefore attractive to engage with, or not. In Latour's case, the qualitative richness of the originating phenomenon (Amazon forest) is traded for increased mobility. Similarly, in the empirical cases in this book the qualitative richness of geological formations, sand, or the marine environment is traded for quantified digital renderings for practical, goal-directed organizational purposes.

## MODES OF KNOWING: SCAFFOLDING

Qualitative judgment, interpretation, and sensemaking are constitutive aspects of human reasoning or "intelligence" (Dreyfus and Dreyfus 2000). These characteristics are central to arguments about the so-called knowledge-intensive work practices related to the delegation of tasks to technology (Autor 2015). Given an understanding of digitalization in general and data-driven

approaches in particular as efforts of quantifying the qualitative, the issue of limits to automation and *human-in-the-loop* takes center stage (Mindell 2015; Shrestha et al. 2019). Rather than offering an abstractly defined, closed formula of the boundary of qualitative/quantitative, what this book provides is an account of the collective, hybrid achievement of uptake into organizational action and decision-making. As von Krogh (2018) notes, "How problem-solving with the involvement of intelligent machines unfolds in organizations remains a poorly understood phenomenon" (406). With increasingly imperialistic tendencies, "data science is portraying itself as a *universal science*" (Ribes 2019, 517). Thus, data-driven efforts need to be conceptualized as fallible projects that may or may not work out for specific purposes and situations; they are performed achievements (Callon 2007; Pickering 2010; MacKenzie 2006). The emergent picture is one in which, on the one hand, datafication for a given purpose may work in practice but not necessarily in theory (to paraphrase LaPorte and Consolini [1991]), while, on the other hand, apparent "automation" (hence quantification) amounts to relocating and/or transforming, not eliminating, the role of the qualitative (Bechmann and Bowker 2019). Berg and Timmermans (2000) make a related argument when arguing that "these orders do not emerge out of (and thereby replace) a pre-existing disorder. Rather, with the production of an order, a corresponding disorder comes into being" (36–37). Hence, automation, expressed informally, is like the game of whack-a-mole: every time you eliminate it in one place, it keeps reappearing elsewhere. An illustrative example is the formation and curation of training sets for data-driven methods.[1] Computer vision relies heavily on supervised algorithms for most applications (Bechmann and Bowker 2019). Generating training sets for supervised algorithms requires significant data work in the form of expert-based, manual labeling. As a consequence, training sets are in high demand and tend to draw extensively on widely available benchmark training sets. In the case of visual perception, this would typically involve the almost ten-year-old and relatively small ImageNet data set (Deng et al. 2009). Yet, "the datasets which machine learning (ML) critically depends on—and which frequently contribute to errors—are often poorly documented, poorly maintained, lacking in answerability, and have opaque creation processes" (Hutchinson et al. 2021, 560).

Similarly, within an information-processing, microeconomic perspective, decision-making can be separated into predictions, which in such a perspective is the production of information you do not have from what you do have, and judgments, which weigh or assess the value of identified predictions. Viewed through this lens, the former—but, crucially, not the latter—is amendable to quantification through data science (Agrawal et al. 2018; see also Shrestha et al. 2019).

A helpful way to think about the emergent hybrid, collective arrangement of data-driven approaches to organizational decision-making is through the notion of *scaffolding* as developed by Wylie from studies in archaeology (see Wylie 2017; Wylie and Chapman 2014; Chapman and Wylie 2014). It offers a way to theoretically characterize the practically working quantification of qualitative sensemaking involved in digital oil. The domain of archaeology shares a number of similarities with oil. Of the different phases of commercial oil discussed in this book, the phase of exploration covered in chapters 4 and 5 is particularly close to Wylie's account of archaeology: knowledge is partial, provisional, fallible, and influenced by the arrival of quantified measurement techniques (including carbon-14 isotope decay, lead isotope analysis, dental enamel for oxygen isotopes). The scaffolding of archaeological knowing builds, and continuously rebuilds, credible background knowledge to develop and mobilize meaningful interpretations of the material evidence, juggling several interpretations (or working hypotheses) at the same time.

Consistent with a performative and relational perspective, "archaeological facts," exactly like facts in digital oil, grapple with the problem "that the tangible, surviving facts of the record so radically underdetermine any interesting claims archaeologists might want to make that archaeologically based 'facts of the past' are inescapably entangled with fictional narratives of contemporary sense-making" (Wylie 2010, 301). Hence, in the case of oil exploration quantified, real-time, IoT data are only meaningful against a backdrop of a qualitative, narrative understanding of geological processes or history.

Furthermore, scaffolding is provisional. In archaeology, as in the geosciences, there is significant competence in moving hermeneutically between close-up, measured data points and taking a step back to gain an appreciation of the broader formative processes: "[Archaeologists] have built up a

repertoire of research strategies specifically designed to mobilise the evidence of human lives and events that survives in an enormous range of material evidence . . . putting material evidence to work in the investigation of a great many different aspects of the cultural past" (Chapman and Wylie 2014, 5). In the case of digital oil, the many ways that data are corroborated, triangulated, and calibrated, as described in part II, are similarly the principal ways of moving back and forth between the micro and the macro.

Scaffolding, Chapman and Wylie (2014) point out, is decentered, distributed, and collective. Scaffolding involves "technical expertise and community norms of practices which are internalized by individual practitioners as embodied skills and tacit knowledge, and externalized in the material and institutional conditions that make possible the exercise, and the transmission of these skill and this knowledge" (55). Scaffolding, in other words, needs to be understood through the infrastructure lens of the machineries of knowing, to which this book adheres. Taken together, scaffolding—dynamic, provisional, decentered—frames the performed achievement of the organizational knowing of digital oil, oscillating between quantified and qualitative expressions.

## MACHINERIES OF KNOWING: "BRINGING WORK BACK IN"

The datafication of society—the digitalization of "everything"—has been observed by several scholars (Lycett 2013; Markus 2017; Leonelli 2014; Kallinikos et al. 2013). Its infrastructure leans on the *platformization* of services and offerings promoting scope and scale (Cusumano et al. 2020; Gawer 2011). The literature on digital platforms originates from new innovation or business operation models, as exemplified by Apple's iOS (Eaton et al. 2015), Google's Search ecosystem (Iyer and Davenport 2008), and Facebook (Rogers 2016). Capitalizing on the way digital platforms enjoy economy of scale alongside a capacity to specialize has led to commercial success for a variety of devices and services, including smartphones (Eaton et al. 2011), advertisements (Alaimo and Kallinikos 2018), social media (Plantin et al. 2018), and wearable technologies (Schüll 2016).

Social media platforms are prominent expressions of how the network externalities of an increasing user base and services drive the evolution

of platforms (Ford and Wajcman 2017; Plantin et al. 2018; Stark 2018; Alaimo and Kallinikos 2018). Users' behavior, attitudes, and preferences and an expanding list of other qualitative characteristics about us are quantified through data traces and algorithmic constructs. Gerlitz and Helmond's (2013) study of the "like economy" is illustrative. It unpacks the formation of and the machineries behind algorithmic constructs (such as reputation, connectivity) that nudge or manipulate the online behavior that feeds the organization and structure of social media platforms. A central illustration is the Like button on Facebook:

> The button provides a one-click shortcut to express a variety of affective responses such as excitement, agreement, compassion, understanding, but also ironic and parodist liking. . . . By asking users to express various affective reactions to web content in the form of a click on a Like button, these intensities can be transformed into a number on the Like counter and are made comparable. (Gerlitz and Helmond 2013, 1358)

Zuboff's (2019) analysis of surveillance capitalism provides a compelling understanding of how platforms feed off, not to mention exploit, our *behavior surplus*, the digital traces of our behavior that we, the users, are seduced to give up in exchange for attractive services.

For all its merit, there is in dominant accounts of the platformization of datafication a strong yet largely implicit and unchallenged assumption of *individualized consumer choice* (exceptions include Bonina et al. 2021). Dominant ways of conceptualizing platformization, epitomized through social media platforms, are culturally and materially shaped by its inception as vehicles to serve mass consumption markets. Thus, the quantification of qualitative behavioral surplus, to use Zuboff's phrase, assumes—and is limited by—a form of methodological individualism. In neoliberal, consumer capitalist societies, "[Individual] choice is a sine qua non of contemporary life. . . . Platforms are not simply cameras that present choice and enable comparisons between different options, but are more akin to engines that govern, drive and expand choice, configuring users within particular discourses, practices and subjectivities" (Graham 2018, 1). Consumer choice is not merely about consumption but, crucially, cultural expression of self-identity—that

is, *Homo eligens* (Bauman 2007). As Kotliar (2020) notes, "Our choices are fast becoming algorithmic. The ubiquity of recommender systems, personalization engines, and user analytics services has made algorithms almost inseparable from our everyday choice-making" (347).

In the context of this book, however, this dominant emphasis on the conceptualization of platformization on consumerism is problematic. It leaves out what is fundamental to this book—namely, the social organizing and institutional fabric in which this platformization/infrastructuring unfolds. In short, the *social* aspects of work—shaped by datafication and fueled by platformization—are left unaccounted for, with an individualistic and atomistic quantification of users. For grasping the role of platformization in promoting and expanding datafication, "bringing work back in" is necessary (Barley and Kunda 2001). The proclaimed, radical transformational capacity of digital platforms—the "Uberization" of organizations (Faraj and Pachidi 2021)—relies heavily on the quantification of atomistic, individualized users,[2] not to mention consumers (Kotliar 2020). In contrast, the platformization of business-to-business or organizational exchange, where users are not atomistic but belong to organizational collectives with dependencies between users' tasks, has had a much slower uptake. Part II of this book vividly demonstrates how organizational and institutional aspects shape the uptake of platformization qua quantification in ways that the prevailing literature, emphasizing individualistic or consumer choice, fails to capture. In other words, the impact of AI and data science is strongest when coupled with platforms and when platforms capture (quantify) atomistic user behavior, with organizational uptake of those same technologies markedly slower (Günther et al. 2017).

Furthermore, if previously the focus was on the theory of the firm (Cyert and March 1963), the significance of comprehensive ecosystems shifts the attention to theorizing about industry-wide transformation (Geels and Schot 2007); it shifts the *unit of analysis* for studying digitalization. Digitally enabled changes during the last many years have focused on intraorganizational change (Vial 2019). The changes heralded by digital platforms pertain to complete industrial ecosystems. This book illustrates this point. The changes analyzed result from broad, mutually reinforcing initiatives to

employ digitalization within the whole ecosystem of oil operators, oil service providers, the engineering, procurement, and construction companies, and vendors and consultants of digital solutions, as well as public authorities and agencies. Scholars of digitalization, then, are well advised to focus on the transformation of whole industries, breaking away from traditional case studies of singular organizations (Williams and Pollock 2012).

In conclusion, reading digitalization through the lens of the attempted quantification of quality, as proposed by this book, is consistent with a commitment to empirically open, analytically critical phenomenon-oriented theorizing (von Krogh 2018). Rather than an ideological, philosophical, or otherwise given boundary between the qualitative and the quantitative, a dynamically evolving, uneven, fallible, and varied landscape opens up, a landscape offering rich opportunities for further scholarly travels.

# Digital Oil

## Machineries of Knowing

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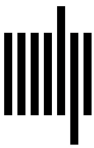

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