Notes

CHAPTER 1

1. The vision attracts interest but, more importantly, investments. The world's first life-size subsea gas compressor prototype has successfully been completed (see Nilsen 2015).
2. Clearly, this is a simplification. Form has content. As Dourish (2017) illustrates with different representations of numbers, Indo-Arabic representations of numbers lend themselves to arithmetic procedures for addition, subtraction, multiplication, and division in ways Roman representations of numbers do not. Hence, especially from the perspective of knowledge infrastructures, this demonstrates the epistemic differences tied to differences in representations of numbers. Despite the simplification of the reference/referent dichotomy, it is useful for outlining key concerns with digitalization.
3. This resonates with a comment Susan Leigh Star once made at a seminar but never (as far as I know) put into writing that the relationship between organization and IT is the same as that between institution and infrastructure. Or as Rob Kling similarly once commented (again, without ever writing about it), design relates to individual houses as infrastructures do to urban planning.
4. Using the adjective (*algorithmic*) rather than the noun (*algorithm*) is consistent with arguments in critical AI of avoiding the essentialist, artifact-centric conceptualization of data science (Bucher 2018; Gillespie 2016; Glaser et al. 2021).
5. See, e.g., Inductive Automation 2018.
6. Chapter 4 was written in collaboration with Marius Mikalsen. Some parts of it have been published in Mikalsen and Monteiro (2018).
7. This is a cartoon version. For instance, field development, which consists of devising the production method; planning the production facilities; and, not least, determining how a new field will tap into the existing infrastructure of pipelines, processing capacity, and refineries, is hardly straightforward.
8. Chapter 5 was written in collaboration with Marius Mikalsen. Parts of it, in an earlier version, have been published as Mikalsen and Monteiro (2021).

9. Chapter 6 was written in collaboration with Thomas Østerlie. Parts of it, in an earlier version, have been published as Østerlie and Monteiro (2020).
10. There is an ongoing debate on "what Norway should live off of after oil." See, e.g., Støa 2020.
11. Chapter 7 was written in collaboration with Elena Parmiggiani. Parts of it, in an earlier version, have been published as Monteiro and Parmiggiani (2019). In addition, a few details have in earlier versions been published in Parmiggiani et al. (2015).

CHAPTER 2

1. For instance, the recent oil discovery in the Norwegian Sea has been planned with a minimal time from discovery to production (NRK 2021).

CHAPTER 3

1. A senior exploration scientist with a major oil operator once confessed that he was increasingly concerned about whether new generations of geologists had sufficient appreciation and knowledge of the physical phenomena, given that field trips to analogues are dwindling in frequency in commercial companies.
2. Other important activities include field development, facility management, and process engineering.
3. *Explorationist* is used as a collective term for the geologists and geophysicists (and other geoscience disciplines, including geochemists). They refer to themselves as *interpretationists* or simply as *G&G*, short for "geology and geophysics." This naming signals the multidisciplinary effort of crafting geological interpretations of the subsurface.
4. Several technologies from different vendors are exploring this, one of which is IntelliServ.
5. The slogan-like characterization into a four-*V* model of big data was proposed by IBM, supplementing an earlier model by Gartner that lacked attention to "veracity," a defining aspect of IoT data; see, e.g., Perry 2017.
6. In recognition of this, several operators have worked out new contracts that stipulate economic sanctions for poor-quality data from the drillers and thus are inscribing incentives for increased data quality into the contracts between the operators and the drilling companies.
7. A few years ago, NorthOil hired one of the large technology providers to help it set up an effective search tool for its intranet based on crawling and indexing its documents and files. As one informant laughingly explained, the search engine could not figure out the correct access regimes. When one of the informant's colleagues tried typing the key word "confidential" into the search engine, "the result was all confidential documents." This resulted in the entire intranet being shut down for three months until the problem was resolved.
8. For instance, as part of the efforts toward integrated operations (see chapter 1), NorthOil formed production optimizing teams consisting of colocated (physically sharing a large desk)

production engineers with short-term (hours and days) time frames and reservoir engineers with longer-term (decades, the life span of an oil field) time frames.

9. There is a time delay of a few years for seismic interpretations.
10. Several exist, including one by Petrovisor.
11. The OSDU initiative was kick-started by Schlumberger and Shell open sourcing key parts of their technology; see OSDU 2021.
12. In Norwegian offshore oil, the NORSOK standard is among the most important; see Standards Norway 2021.

CHAPTER 4

1. This is not to deny the considerable opposition and critique from many of the companies selling these ads, such as when Procter and Gamble, the biggest buyer of commercial ads worldwide, voices its frustration with some of the results of programmatic advertising. See Handley 2017.
2. Jackson uses the notion of articulation work as a form of invisible work.
3. There are exceptions. The Norwegian Petroleum Directorate, for instance, will commission seismic surveys on its own if and when it believes an area needs surveying but has yet to be surveyed by any of the commercial actors.

CHAPTER 5

1. There are, e.g., a number of open-source tools available, including Hadoop, Apache Spark, MapReduce, Cassandra, MongoDB, and Tableau.
2. As Marcus (2018) reminds us, the qualifier "deep" refers to the number of hidden layers in a neural network. It is thus a technical feature of the technology, not to be mistaken for psychological "deep" learning.
3. Similarly, work on explainable AI and XAI (explainable AI) explores methods to enhance the transparency, and hence the accountability, of black-boxed AI methods (Miller 2019).
4. Vitrinite reflectance is a measurement of the optical properties of vitrinite, a form of organic matter contained in rock samples. Vitrinite is used to diagnose the maturity of source rock, as its reflectance is sensitive to temperature ranges that correspond to those of hydrocarbon generation.

CHAPTER 6

1. Leaking gas is considered among the most dangerous situations on an offshore petroleum installation because of the catastrophic consequences of gas explosions (Kongsvik et al. 2011). While the 2010 Deepwater Horizon catastrophe in the Gulf of Mexico was not caused by a punctured pipeline, it illustrates the twin dangers of an uncontrolled oil spill causing

disastrous environmental damage and the consequences of leaking gas that ignites and subsequently explodes the topside platform.

2. The term "digitalization" has many meanings. With automation as the formative idea, studies of digitalization in the 1980s and 1990s were predominately conceptualized as *computerization* (Kling 1996). Gradually acknowledging the expanded depth and width implied in embracing the transformative capacity, there has since been a proliferation of concepts to capture digitalization beyond the automation/substitution tied to the concept of computerization. "Virtual/ization" is one widely used term. Some use it loosely to denote when physical mechanisms or processes are conducted by computers rather than physically (Overby 2008) or where face-to-face communication is mediated by computers (Jarvenpaa et al. 1998). In contrast, Bailey et al. (2012) provide a definition in which they identify digitization (the creation of computer-based representations of physical phenomena) as a necessary precursor to and hence different from virtuality—i.e., the engagement with these representations. This useful clarification corresponds to Yoo et al.'s (2010) distinction between digitization as the coding into digital formats and digitalization as the processes of engagement made possible by digitization. Here, Bailey et al.'s (2012) notion of the virtual is adopted.

3. The taxonomy into three types is found, without resorting to Peirce, in Knorr Cetina (1999). She identifies three types of data. Physical phenomena, first and traditionally, may be staged to produce data that correspond with the phenomena directly (i.e., the indices in Peirce). Second, the physical conditions are manipulated to yield processed, partial versions of data that are equivalent or similar (i.e., icons in Peirce). Third, and most radically, physical phenomena are mere signatures and footprints of events, providing data as signs (i.e., symbols).

4. This and later names are anonymized.

CHAPTER 7

1. Interestingly, the opposition is escalating from within the industry, and not only outside. For instance, in their annual report the International Energy Agency, historically a strong supporter of the fossil fuel industry, issued a remarkably strong conclusion that the "exploitation and development of new oil and gas fields must stop this year" (see Harvey 2021) and ExxonMobil, against the chairpersons, has had to accept the arrival of three new board members widely viewed as proponents of an environmentally friendly agenda.

2. Clearly, this is a simplification and not quite as naively technocratic as it may seem. Yet it acts as a navigating ideal that significantly shapes the procedure and content of the political processes.

3. The figure includes oil reserves only, not natural gas. For many of the fields, there are more gas than oil reserves. The main point, however, still applies—namely, that there is in the oil industry a mounting concern about the lack of untapped hydrocarbon reserves, which adds to their appetite for new areas in the Arctic.

4. An interactive map of environmental "values" jointly created by the Norwegian Directorate of the Environment and the Mapping Agency (Kartverket) inspired the notion in EnviroTime of the value of biomass; see Barentswatch 2021.

5. The lobbying succeeded. In the twenty-third concessional round announced in 2016, ten new licenses were opened for oil and gas activities, three of these in the Norwegian part of the Barents Sea. A coalition of environmental NGOs sued the government, claiming that the twenty-third round went against the rights to a healthy environment written into the Constitution. The case was lost in the first level of the courts in January 2018. Oil exploration in Venus is still banned.

CHAPTER 8

1. More formally, this insight may be formulated by underscoring the "slight surprise of action" (Latour 1999) or, alternatively, the way side effects and unintended outcomes overtake the intended ones (Beck 1992; Perrow 2011).
2. Zuboff (2019) is on to the same idea when pointing out how Skinner's behaviorism, which similarly relies on methodological individualism, is an illuminating way to understand the perspectives on users' behavior (implicitly) pursued by the big-tech platform companies. What Zuboff fails to discuss, however, is the role of platforms in organizational and institutional settings where users are not atomistic.

APPENDIX

1. Welfare technologies is a notion also known as ambient technologies. It consists of a variety of largely sensor-based services for monitoring health conditions, including not only blood sugar levels and respiration but also patient safety services such as fall detectors and GPS tracking of Alzheimer patients.

This is a section of doi:10.7551/mitpress/14604.001.0001

Digital Oil

Machineries of Knowing

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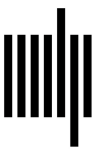
Citation:

Digital Oil: Machineries of Knowing
By: Eric Monteiro
DOI: 10.7551/mitpress/14604.001.0001
ISBN (electronic): 9780262372282
Publisher: The MIT Press
Published: 2022

The open access edition of this book was made possible by generous funding and support from MIT Press Direct to Open



The MIT Press

The MIT Press would like to thank the anonymous peer reviewers who provided comments on drafts of this book. The generous work of academic experts is essential for establishing the authority and quality of our publications. We acknowledge with gratitude the contributions of these otherwise uncredited readers.

This book was set in Adobe Garamond and Berthold Akzidenz Grotesk by Jen Jackowitz.

Library of Congress Cataloging-in-Publication Data

Names: Monteiro, Eric, author.
Title: Digital oil : machineries of knowing / Eric Monteiro.
Description: Cambridge, Massachusetts : The MIT Press, [2022] | Series: Infrastructures. | Includes bibliographical references and index.
Identifiers: LCCN 2022003259 (print) | LCCN 2022003260 (ebook) | ISBN 9780262544672 (paperback) | ISBN 9780262372282 (pdf) | ISBN 9780262372299 (epub)
Subjects: LCSH: Petroleum industry and trade—Norway. | Oil fields—Norway—Data processing. | Oil field equipment and supplies industry—Norway—Technological innovations.
Classification: LCC HD9575.N62 M66 2022 (print) | LCC HD9575.N62 (ebook) | DDC 338.2/72809481—dc23/eng/20220124
LC record available at https://lccn.loc.gov/2022003259
LC ebook record available at https://lccn.loc.gov/2022003260