

Insights from history on the parallel digital & sustainable transitions

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Consensus has built on the need for a sustainable and digital transition of industries to happen in parallel. Sustainability may come from electrification of currently carbon-reliant activities, while digitalisation promises to augment and enhance the abilities of humans. Yet literature suggests a complex relationship between the interconnected social and technical systems that must co-evolve to deliver these transitions, as well as the likely impossibility of their top-down control. Insights may be derived from the first wave of electrification that began over a century ago. In particular, we develop the wave metaphor by focusing on the less visible undercurrents that feed waves and transitions. Based on a systematic review of historical transitions, the paper identifies international cases of electrification and examines factors that could explain past and inform future practice. In particular, it suggests that the transition from ownership to access may be an important but underdeveloped factor.

Track 12 – Innovation.

Word count (excluding tables and references) – 1651

Developmental paper, plans for development prior to presentation – the paper is part of an ongoing research programme that commenced with a systematic review. Ahead of the conference, the authors will analyse a number of specific cases and elaborate the common factors, to derive implications for theory, practice and policy.

Introduction

As challenging as the transition to a more digital and sustainable future may appear, it is not the first. We may be undergoing a 2nd Deep Transition (Schott and Kanger, 2018; Kanger and Schot, 2019) or a 3rd Industrial Revolution (Rifkin, 2011). We may be seeing Industrie 4.0 (Schwab, 2015); Industry 5.0 (European Commission, 2022), or a 6th Kondratieff wave (Grinin et al., 2017). This research is guided by the question *what insights from previous industrial transitions can inform management of the current one?*

The current industrial transition is the successor of a series of earlier transitions that have reshaped the world, notably since the eighteenth century (Schot and Kanger 2018). These deep transitions have revolutionised the resources of energy and power, multiplying many times over the resources available for manufacturing. These resources evolved thanks to a spectrum of technologies deploying steam, electric, fossil-based fuels, and nuclear power, transforming materials, infrastructures, and the ecosystems in which they sit in profound and enduring ways (Perez 2010). Undoubtedly, moreover, these transitions have been accompanied by tremendous transformations in the earth's ecology, leading to serious questions about decisions made in the past and decisions that must be made for our future, especially as regards how energy is generated, distributed and used (Russell et al 2011).

Today's industrial transition is distinct, however, insofar as its aims are not only framed in terms of greater efficiency or power, but also in terms of a cleaner (decarbonized) and more

sustainable future, especially through digitization. The impacts of industrial society on the planet are now widely recognised and reversing them is a central concern for policy makers. In this context, a twin transition is viewed with promise, combining an energy transition away from fossil fuels towards renewable energy with a digital transition to embed technologies such as Artificial Intelligence (AI), Internet of Things (IoT), Digital Twins (DT) and Additive Manufacturing (AM). For example, the UK government's net zero strategy focuses on electrification of heating, transportation and energy storage in the medium term (BEIS, 2021a). In the short term, however, it prioritises resource and energy efficiency, which are expected to result from digital technologies (BEIS, 2021b). The European Commission similarly connects sustainability and digitalisation in a twin-transition (Ortega-Gras et al., 2021). The risk of not doing so may be a digital transformation that is not environmentally (or socially) sustainable (Fouquet and Hippe, 2022).

Theoretical background

A broad body of literature considers the complex interplay between new technologies, for example electric vehicles, computers and steam engines; the sources of energy that drive them, including fossil fuels, water and renewables; the products and services created by these technologies and power sources; and the people and social systems that may benefit from them. Whereas there may be a tendency to view each in isolation, frameworks such as the Multi-Level Perspective (MLP) help to give a more complete picture. For example, Turnheim and Geels (2013) explore the destabilisation of regimes through MLP, considering the British coal industry. MLP considers a niche level, in which innovations can be cultivated, for example more sustainable alternatives to existing technologies, which may not be ready to compete in an open market but require development in collaboration with users (e.g. Schot and Geels, 2008). It also considers regimes, which create a structure within which niches are shaped and reciprocally shape the structure (Geels and Schot, 2007; Giddens, 1984). MLP underlies a framework of deep transitions (Schot and Kanger, 2018; Kanger and Schot, 2019) in which sociotechnical changes are intertwined and happen over long periods. This view suggests that industrialisation, over decades has created a regime and implicit rules related to markets, structures and consumption that are no longer sustainable.

Given the managerial challenges of a parallel digital and sustainable transition, we follow recent calls for the use of history (Decker et al 2021) as a resource and managerial capability. Suddaby et al (2019) have argued that history can not only inform critical analytical tasks in business but also underpin dynamic processes such as the seizing of opportunities. While most history is conceptualized from an objective or interpretative angle, according to which history narrates past events on the basis of empirical evidence, or else provides explanations of such events through the critical interpretation of sources, Suddaby et al propose a 'prospective' function for history by which historic cases of business or industrial activities enable today's business and industrial decision makers to engage in 'future perfect' thinking, envisaging plausible eventualities calibrated on the basis of historical parallels and precedents.

Understanding and interpreting the past can allow the pitfalls and failures of the past to be avoided. Moreover, developing a grammar of technology (Hård and Knie, 1999) allows the network of factors and dynamics affecting past success to be explored. Historical precedents are widely used in studies of innovation but Mendonça (2013), citing the example of the sail ship effect, cautions that the original sources must be carefully and deeply analysed. While

the threat of new technologies can stimulate innovation in older ones, the sail ship effect does not seem to be supported by the data on steam and sail ships. Historical analyses offer rich sources to explore the various factors and their interplay, which could inform managerial action. We examine cases that review or revisit accepted historical narratives. Kirsch and Mom (2002) revisit the apparent failure of the Electric Vehicle Company to suggest poor timing rather than the accepted wisdom that electric cars were doomed to fail. Chatterjee (2020) examines competing explanations to consider the complex influences of nationalism and decolonisation on the electrification efforts of Asian nations. And Hirsh (2018) sheds new light on rural electrification, countering prevailing narratives centred on government intervention to suggest the roles of decentralised networks and power companies.

The significance of these insights for today's challenges is twofold. From a transitions perspective, historical self-awareness is crucial to businesses who desire to move into new areas; Suddaby et al (2019) consider this from the perspective of organizational history and management, but we would argue its logic is relevant across sectors or industries as a whole. From a strategic capacity perspective, moreover, historical awareness is a critical resource supporting dynamic capabilities (Teece 2007), enhancing the ability of decision makers to reconfigure not only niche technologies and their own firms, but also the ecosystems in which their businesses and offerings sit.

Methods

Literature reviews fall on a miner-pro prospector continuum (Breslin and Gatrell, 2023). Miners deeply examine a bounded and established domain, while prospectors work across disciplinary silos and knowledge boundaries. We adopt the latter approach, drawing on literature from across social sciences to establish a new boundary. We conducted a Systematic Literature Review (SLR) to incorporate relevant research on historical transitions. Following Tranfield et al (2003), the literature search involved the following steps:

1. Identification of research: Drawing on prior literature we developed an initial set of search strings related to four key transitions: mechanization, electrification and computerization.
2. Selection of studies: Search strings were used in academic journal databases (Scopus and Web of Science), the scope of the search was restricted to: Arts and Humanities; Social Sciences; Business and Management; and Economics. A total of 1458 articles was identified.
3. Study quality assessment: Articles were screened for inclusion on the basis they reported historical rather than current events and could offer relevant practical insights. Articles were excluded where their focus was overly technical and not offering management implications. E.g. electrification of 20th century agricultural production could be included, while electrification of automobiles in 2020 would be excluded. An engineering evaluation of a specific technology would be rejected whereas a historical study of a technology's adoption would be included. The total was reduced to 229 articles for review.
4. Data extraction and monitoring: Articles were reviewed independently by two researchers to identify themes and trends within and across the transitions. For example, economic analysis from multiple transitions offers evidence of increasing demand for skills and improvements in energy efficiency with each subsequent transition. Additionally, specific cases of interest were identified for more detailed investigation.

5: Data synthesis: In the current phase of research, a number of specific cases are investigated in greater detail to identify parallels to the present-day parallel transition. The focus is on historical cases of electrification, in which the challenges and lessons may be closest.

6: Impact: To make the insights accessible to decision-makers, a set of narrative cases are developed, relating to the identified themes. These present historical decisions that can be related to the challenges and themes of digitalization and can help to inform managerial action.

Expected Findings

We analyse a number of historical cases of electrification, in order to apply the deep transitions framework and identify insights. In particular, we identify the changing attitudes to ownership and access of physical goods as a central part of the deep transition. Mass production, mass consumption and private ownership are seen as part of the regime and sociotechnical system that evolved in large part due to the approach of automotive manufacturers (Kanger and Schot, 2019). An alternative model of access to (rather than ownership of) electric vehicles emerged earlier but did not become dominant (Kirsch and Mom, 2002). Rifkin (2001) describes the present time as the “age of access”, in which the desire for ownership of physical goods has been replaced by a preference for access to the experiences they can create. Meanwhile Cusumano et al (2015) examined the evolution of industries suggesting cycles in which services rather than products are more important in early and late phases – for example reducing the risks of owning new technologies by leasing or sharing. Conceptions of mobility-as-a-service, or heat-as-a-service seem to represent a marked transition. Yet historical cases also demonstrate that resource-sharing may play an underexamined part in transitions. For example, creating electric infrastructure may have been seen as part of developing a shared national identity across Asian nations gaining independence from colonial powers (Chatterjee, 2020).

Acknowledgement

This research has been funded under the ESRC Made Smarter Network+ (“InterAct”) Grant Reference J17293 / ES/W007231/1 – SR#1

References

- BEIS (Department for Business, Energy and Industrial Strategy). (2021a). Digitalising our energy system for net zero, strategy and action plan. [<https://www.gov.uk/government/publications/digitalising-our-energy-system-for-net-zero-strategy-and-action-plan>], last accessed 10th February 2023
- BEIS (Department for Business, Energy and Industrial Strategy). (2021b). Industrial Decarbonisation Strategy. [<https://www.gov.uk/government/publications/industrial-decarbonisation-strategy>], last accessed 10th February 2023
- Breslin, D., & Gatrell, C. (2023). Theorizing Through Literature Reviews: The Miner-Prospector Continuum. *Organizational Research Methods*, 26(1), 139–167. <https://doi.org/10.1177/1094428120943288>
- Chatterjee, E. (2020). The Asian anthropocene: Electricity and fossil developmentalism. *Journal of Asian Studies*, 79(1), 3–24. <https://doi.org/10.1017/S0021911819000573>
- Cusumano, M. A., Kahl, S. J., & Suarez, F. F. (2015). Services, industry evolution, and the competitive strategies of product firms. *Strategic Management Journal*, 36, 559–575. <https://doi.org/10.1002/smj>

- Decker, S., Hassard, J., & Rowlinson, M. (2021). Rethinking history and memory in organization studies: The case for historiographical reflexivity. *Human Relations*, 74(8), 1123–1155. <https://doi.org/10.1177/0018726720927443>
- European Commission. (2022). Industry 5.0, a transformative vision for Europe. Available at [https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/industry-50_en], last accessed 10th March 2023
- Fouquet, R., & Hippe, R. (2022). Twin transitions of decarbonisation and digitalisation: A historical perspective on energy and information in European economies. *Energy Research and Social Science*, 91. <https://doi.org/10.1016/j.erss.2022.102736>
- Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, 36(3), 399–417. <https://doi.org/10.1016/j.respol.2007.01.003>
- Geels, F. W. (2010). Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. *Research Policy*, 39(4), 495–510. <https://doi.org/10.1016/j.respol.2010.01.022>
- Giddens, A. (1984). *The constitution of society: outline of the theory of structuration*. Polity Press.
- Grinin, L., Grinin, A., & Korotayev, A. (2017). The MANBRIC-Technologies in the Forthcoming Technological Revolution. In *Studies on Entrepreneurship, Structural Change and Industrial Dynamics* (pp. 243–261). Springer Nature. https://doi.org/10.1007/978-3-319-49604-7_13
- Hirsh, R. (2018). Shedding new light on rural electrification: The neglected story of successful efforts to power up farms in the 1920s and 1930s. *Agricultural History*, 92(3), 296–327. <https://doi.org/10.3098/ah.2018.092.3.296>
- Hughes, T. P. (1986). The Seamless Web: Technology, Science, Etcetera, Etcetera. *Social Studies of Science*. 16(2), 281-292.
- Hård, M & Knie, A (1999). The Grammar of Technology: German and French Diesel Engineering, 1920-1940. *Technology and Culture*, 40(1), 26–46.
- Kanger, L., & Schot, J. (2019). Deep transitions: Theorizing the long-term patterns of socio-technical change. *Environmental Innovation and Societal Transitions*, 32, 7–21. <https://doi.org/10.1016/j.eist.2018.07.006>
- Kirsch, D. A., & Mom, G. P. A. (2002). Visions of transportation: The EVC and the transition from service-to product-based mobility. *Business History Review*, 76(1), 75–110.
- Mendonça, S. (2013). The “sailing ship effect”: Reassessing history as a source of insight on technical change. *Research Policy*, 42(10), 1724–1738. <https://doi.org/10.1016/j.respol.2012.12.009>
- Ortega-Gras, J.-J., Bueno-Delgado, M.-V., Canavate-Cruzado, G., & Garrido-Lova, J. (2021). Twin Transition through the Implementation of Industry 4.0 Technologies. *Sustainability*, 13(13601). <https://doi.org/10.3390/su132413601>
- Perez, C. (2010). Technological revolutions and techno-economic paradigms. *Cambridge Journal of Economics* 2010, 34(1), 185–202. <https://doi.org/10.1093/cje/bep051>
- Rifkin, J. (2001). *Age of Access: The New Culture of Hypercapitalism, Where All of Life is a Paid-for Experience*
- Rifkin, J. (2011). *The third industrial revolution, how lateral power is transforming energy, the economy and the world*. Palgrave-MacMillan
- Russell, E., Allison, J., Finger, T., Brown, J. K., Balogh, B., & Carlson W Bernard. (2011). The Nature of Power, Synthesizing the History of Technology and Environmental History. *Technology and Culture*, 52, 246–259.

- Schot, J., & Kanger, L. (2018). Deep transitions: Emergence, acceleration, stabilization and directionality. *Research Policy*, 47(6), 1045–1059. <https://doi.org/10.1016/j.respol.2018.03.009>
- Schwab, K. (2015). The fourth industrial revolution, *Foreign Affairs*, December 12th, available at [<https://www.foreignaffairs.com/world/fourth-industrial-revolution>], last accessed 10th March 2023.
- Suddaby, R., Coraiola, D., Harvey, C., & Foster, W. (2020). History and the micro-foundations of dynamic capabilities. *Strategic Management Journal*, 41(3), 530–556. <https://doi.org/10.1002/smj.3058>
- Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed managerial knowledge by means of systematic review. *British Journal of Management*, 14, 207–222.
- Turnheim, B., & Geels, F. W. (2013). The destabilisation of existing regimes: Confronting a multi-dimensional framework with a case study of the British coal industry (1913-1967). *Research Policy*, 42(10), 1749–1767. <https://doi.org/10.1016/j.respol.2013.04.009>