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Deep transitions: Emergence, acceleration, stabilization and directionality

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ABSTRACT

Industrial society has not only led to high levels of wealth and welfare in the Western world, but also to increasing global ecological degradation and social inequality. The socio-technical systems that underlay contemporary societies have substantially contributed to these outcomes. This paper proposes that these socio-technical systems are an expression of a limited number of meta-rules that, for the past 250 years, have driven innovation and hence system evolution in a particular direction, thereby constituting the First Deep Transition. Meeting the cumulative social and ecological consequences of the overall direction of the First Deep Transition would require a radical change, not only in socio-technical systems but also in the meta-rules driving their evolution – the Second Deep Transition. This paper develops a new theoretical framework that aims to explain the emergence, acceleration, stabilization and directionality of Deep Transitions. It does so through the synthesis of two literatures that have attempted to explain large-scale and long-term socio-technical change: the Multi-level Perspective (MLP) on socio-technical transitions, and Techno-economic Paradigm (TEP) framework.

1. Introduction

Recently (2015), the United Nations formulated 17 Sustainable Development Goals, calling for revolutionary greener production, increased social justice, a fairer distribution of welfare, sustainable consumption patterns, and new ways of producing economic growth. Others are promoting "smart, sustainable and inclusive growth" (European Commission, 2010), "a circular economy" (European Environment Agency, 2016), or "a social contract for sustainability" (WGBU, 2011). However, it remains an open question how these goals are to be achieved, especially in the context of the current double challenge of environmental degradation (IPCC, 2014; Steffen et al., 2015) and social inequality (Piketty, 2014; Milanovic, 2016).

Drawing on much work in the sustainability transitions field, we start from the assumption that in order to respond to these interconnected social, economic and ecological challenges, fundamental changes are necessary in a wide range of socio-technical systems for the provision of energy, mobility, food, housing, communication, water, healthcare, education, finance, etc. These systems encompass production, distribution and consumption, and should thus not be confused with sectors. They can be defined as configurations of actors, technologies and institutions for the fulfilment of societal functions that form the material backbone of modern civilization. In this paper we develop a Deep Transition (Schot, 2016) framework for understanding how changes across multiple systems became connected and coordinated, developing a common directionality in the long run. We thus devote this paper to exploring the following broad research question: how can we understand the emergence, acceleration, stabilization and directionality of Deep Transitions?

A Deep Transition is formally defined as a series of connected and sustained fundamental transformations of a wide range of socio-technical systems in a similar direction. Examples of this directionality[1] include a move towards increased labour productivity, mechanization, reliance on fossil fuels, resource-intensity, energy-intensity, and reliance on global value chains. Our assumption is that this process of building connections between change processes in multiple systems takes on wave-type properties, unfolds through centuries, and is implicated in broader transformations of societies and economies. In this conceptualization each wave is broadening and deepening the Deep Transition, but should not be seen as a Deep Transition in itself. The Deep Transition refers to the overall change process, and is thus comparable to what Polanyi (2001 [1944]) called the Great Transformation. Others have analysed this as the process of industrialization (Mokyr, 1990; McNeill and McNeill, 2003; McClellan and Dorn, 2015), or as the

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[1] The notion of directionality was introduced by Stirling (2008, 2009) as part of his call for opening up the process of technical change for alternative options. He builds on the broader idea that socio-technical change has a direction, choices are made between directions and actors gradually become blind to alternatives, which is a central tenet of much of the innovation studies literature. Our notion of directionality also draws on this idea (see also Weber and Rohracher, 2012: 1042–1043).

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emergence of a distinctive socio-metabolic profile of industrial societies (Fischer-Kowalski and Haberl, 2007; Swilling, 2013; Haberl et al., 2017). What makes the Deep Transitions approach distinctive is its emphasis on socio-technical (vs. 'natural' and/or 'social') systems, its attention to the parallel evolution of single systems, complexes of systems as well as the broader and long term transformations of industrial society as a whole, and the role of rule-systems (called regimes and meta-regimes) in driving the directionality of the entire process.

We call the build-up of various socio-technical systems in waves, taking place over the 19th and 20th centuries, the First Deep Transition.[2] On one hand, the historical expansion and globalization of this First Deep Transition led to unprecedented levels of wealth and welfare in the Western world. However, on the other hand the whole process was marred with recurrent problems such as climate change (caused by the use of fossil fuels), pollution, an enormous waste of resources (caused by the assumptions of limitless supply of resources and limitless capacity to absorb waste), inequality (caused by system innovation mainly aimed at the richer markets) and persistent unemployment (caused by a relentless emphasis on productivity growth). As these harmful outcomes occurred, re-occurred, cumulated and amplified, serious worries started to be expressed about the sustainability of this path (Meadows et al., 1972; Brown, 1984). It became clear that the challenge of sustainability requires a fundamental change of production, distribution and consumption patterns.

Recently these concerns have created increasing pressures on existing socio-technical systems, thereby stimulating possibilities for the emergence of the Second Deep Transition: an overhaul of the directionality of the First Deep Transition and therefore the most fundamental principles guiding the mode of operation of socio-technical systems constituting modern societies. We suggest that this sea-change has gradually started to unfold since the 1970s in specific niches, not as a mainstream development but rather as an undercurrent of historical change. Examples include renewable energy development, alternative food production practices, emergence of new types of mobility services, and many others. In this paper we seek to undertake a first step towards identifying and theorizing the significance of these niches in the context of long term transition processes.

While our overall ambition is to create a new theoretical framework conceptualizing the co-evolution of single socio-technical systems, interconnected systems and industrial modernity as a whole, in this paper we focus on the first piece of the puzzle: understanding the relationships between shifts in single and interconnected systems. The long term patterns that formatted industrial modernity, and were generated by the build-up of these connections, will be discussed in a follow-up paper. For the conceptualization of the development of connected systems in the long term, we draw on two well-established, empirically supported and complementary approaches: the Techno-economic Paradigm theory (TEP) and the Multi-level Perspective on socio-technical transitions (MLP). Section 2 provides a critical overview of both, paving the way for a synthesis in Section 3, where we present the Deep Transition framework. Section 4 provides a final discussion, outlining a research strategy and indicating the need for further conceptual work.

2. Theorizing deep transitions

The notion of Deep Transitions developed here entails a focus on large-scale and long-term socio-technical systems change. Existing literature on the topic often operates on the level of individual socio-technical systems. It analyses how socio-technical systems emerge, grow, mature and decline, and how shifts from one system to another take place. Examples of such approaches are Large Technical Systems theory (Hughes, 1983; Nye, 1998), the Technological Innovation System approach (Carlsson and Stankiewicz, 1991; Bergek et al., 2008, 2015), and the Multi-level Perspective (MLP) on socio-technical transitions (Geels, 2005a; Grin et al., 2010). The analysis of the long term development of a set of interrelated multiple socio-technical systems and the environment in which these systems reside has received somewhat less attention in comparison: relevant approaches include the Control Revolution thesis (Beniger, 1986), Eras of Technology concept (Misa, 2004), and the Techno-economic Paradigm (TEP) framework (Freeman and Louçã, 2001; Perez, 2002). What is largely missing from current literature, however, is how individual socio-technical systems have historically become connected into complexes of systems, developed traction in particular directions, and how these complexes, in turn, have increasingly become part of the socio-material fabric of our economies, polities, cultural frameworks, social interactions and everyday practices.

We have chosen to address this gap by integrating MLP and TEP in a new Deep Transition framework. Admittedly, taken together TEP and MLP is not the only combination possible, but we believe that it provides a promising and powerful starting point for understanding Deep Transitions. Both draw together the insights of various disciplines such as sociology, economic history or institutionalism; at the same time, both are based on evolutionary theory, making their ontological foundations compatible. Perhaps more importantly, the synthesis allows the conceptualization of the endogenous and co-evolutionary change of individual and multiple systems, the build-up of a long-term change process in a wave-like pattern, and the overall directionality of this process. Finally, both frameworks are underpinned by substantial empirical research and they are conceptually complementary, providing remedies for each other's shortcomings.

2.1. Techno-economic paradigm framework

The Techno-economic Paradigm framework (TEP) (Perez, 1983; Freeman and Perez, 1988; Tylecote, 1992; Podobnik, 1999; Freeman and Louçã, 2001; Perez, 2002; Dewick et al., 2004; Drechsler et al., 2009; Mathews, 2013, 2014) has generally focused on explaining long waves: 40–60 year long cyclical variations in economic growth. What it brings to the Deep Transition framework is the idea that the First Deep Transition emerged through a set of distinctive waves. Various mechanisms have been assumed to be responsible for creating these historical wave-like patterns, including the availability of credit, fluctuations in the production of gold, the emergence of new states and demographic changes (see Papenhausen, 2008: 790–793; Köhler, 2012: 3; Bernard et al., 2014: 89, for partly overlapping lists of causes). What makes TEP distinctive is its stress on clusters of interrelated technological, organizational and institutional innovations as drivers of these waves. It is argued that, historically, these clusters have led to major increases in productivity and product quality, structural changes in production and consumption, and long-term economic growth, as well as major political and cultural impacts (Freeman and Louçã, 2001; Perez, 2002). Each wave evolves from small beginnings in certain sectors and/or regional areas and ends up encompassing the entire economies and societies of leading countries, gradually diffusing to other countries as well. Since the beginning of the Industrial Revolution, there have been five such waves.

Perez (2002), who prefers to speak about Great Surges of Development instead of long waves, identifies the key components of these transformations. She suggests that each surge has consisted of an important all-pervasive low-cost input, often a source of energy (e.g. coal or oil) or a new material (e.g. plastics), new technologies, products and processes, and new or fundamentally redefined infrastructures (Perez, 2010). However, the transformative power of the surge is not located in

[2] We have chosen this particular numbering because the conceptualization we put forward does not apply to pre-modern societies. It is rooted in the build-up of a set of socio-technical systems that did not exist before; their rise to dominance in fact characterizes the genesis of the First Deep Transition. We are aware, however, that from different perspectives, such as the energy and material usage profile, a good case can be made that the agrarian shift was of similar historical significance (see Fischer-Kowalski and Haberl, 2007; Haberl et al., 2017, for more detail).