



# An outline of future-oriented dialectics: Conceptualising dialectical positions, trajectories and processes in the context of futures research

Toni Ahlqvist

*Finland Futures Research Centre, Turku School of Economics, University of Turku, Finland*

## ARTICLE INFO

### Keywords:

Future-oriented dialectics  
Dialectical process  
Dialectical position  
Tension  
Contradiction  
Antagonism

## ABSTRACT

The paper outlines a dialectical approach to analyse societal tendencies by emphasising future tensions, contradictions and antagonisms. First, the theoretical baseline of the approach is a commitment to the basic tenet of dialectical thinking: a perspective of the world as a process and a becoming. Second, the approach focuses on societal and socio-technical change trajectories and various dynamics in between. Third, it is based on systems and complexity thinking, particularly the idea of a societal system consisting of various parallel and contradictory trajectories. Methodologically, the approach emphasises dialectical thinking in two lenses: positions and processes. Dialectical positionality refers to basic dialectical positions as outcomes of the dynamics between the spatiotemporal trajectories in the societal system. Dialectical processuality refers to the processual nature of future-oriented dialectics, that is, the unravelling of the spatio-temporal processes and trajectories that lead to changes in the societal system. Dialectical processes are divided into two dynamic levels: trajectory and system. The paper presents stylised examples of positions and processes on these two levels.

## 1. Introduction

In this paper, I formulate a dialectical approach to analyse future-oriented societal development tendencies, which I call future-oriented dialectics. I argue that this dialectical approach enables a dynamic perspective to scrutinise the complex impacts of societal development trajectories. This perspective is useful for future-oriented analyses, especially considering the multiple juxtapositions that societies and economies continue to face. Nevertheless, dialectical analyses have remained relatively rare in futures research, which may be due to the fact that dialectics are yet to be distinctively conceptualised in the context of futures research. Here, I propose such a conceptualisation.

A crucial aspect in this conceptualisation is the need to search for futures approaches and methods that look beyond consensus building and linear analyses. Dialectical thinking, even in its simplest form, is a step in the path to a more grounded futures perspective. Dialectical futures research provides a counterpoint to linear futures imagination and asserts that the futures imagined in the present are never linear or one-directional; instead, they are complex, messy and contradictory. I suggest that the dialectical approach provides keys to a more dynamic understanding of the links between futures, present(s) and past(s).

In the context of futures research, dialectics can be understood as a heuristic that unravels the possibility of analysing the variegated positional, relational and spatio-temporal dynamics of societal development trajectories as they “traverse” towards futures. The

*E-mail address:* [toni.ahlqvist@utu.fi](mailto:toni.ahlqvist@utu.fi).

<https://doi.org/10.1016/j.futures.2022.103037>

Received 16 November 2020; Received in revised form 31 August 2022; Accepted 12 September 2022

Available online 16 September 2022

0016-3287/© 2022 The Author. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

key idea of future-oriented dialectics is to scrutinise dynamics with a critical sensitivity towards tensions, contradictions, antagonisms and conflicts of societal trajectories. This sensitivity disrupts the supposition of linearly progressing futures images, which is the explicit assumption of various extrapolative futures methods and the implicit assumption of multiple consensus-oriented methods.

The paper tackles the question of how dialectical positions and processes could be enacted for the study of societal change. The perspective is suitable for various societal trajectories, but as I assert, it is particularly suited to analysing socio-technical changes. The development of technology and the societal transformations catalysed by technologies are a central tenet of the Western liberal worldview: The narrative of technological transformation and its future imaginaries forms the baseline of economic governance and related politics (see Beckert, 2016). Technological development has become a key part of politics in Western states, for example, through the idea of state renewal by digitalisation and the ideal citizens of digital societies.

This paper is divided into five main sections. The following second section sets the theoretical basis and focuses on varieties of dialectics. The third section builds a reconstructed dialectical framework based on an analysis of positions and processes. The fourth section discusses stylised examples of how a dialectical futures approach can be utilised to explore selected socio-technical trajectories. The fifth section concludes the paper and scans alternative future options for a dialectical futures approach.

## 2. Dialectical varieties

### 2.1. Dialectics and futures research

In this section, I discuss the socio-theoretical foundations of the dialectical approach and its connections to futures research. As an approach, dialectic has its roots in classical Greek philosophy. It is etymologically connected to the concept of dialogue. Dialectical futures research, as conceptualised here, is based on Hegel's notion of dialectics (Hegel, 1977). Briefly, Hegelian dialectic is based on the notion that some idea or argument becomes a thesis, that is, a starting point for a dialectic process, which is again challenged by an opposing anti-thesis. When this process advances, the theses and anti-theses can integrate into a synthesis that can then become a new thesis and so on. The dialectical process is a dynamic and continuously moving interpretation of societal development that emphasises tense interactions. Hegel's philosophical construction is founded on the notion of a historical spirit (*Geist*), a sort of collective being that is constantly becoming through a dialectical process. The notion of a spirit creates a teleological aspect of the dialectical process, which has been interpreted as a "mystic element" in Hegelian thought.

Marx (1976), the renowned historical dialectician, turned the Hegelian process "upside-down" and argued that the dialectical process is not based on an immaterial historical spirit but on the material foundations of society. This means that societal development is not interpreted as the inexorable perfection of the spirit but as a constant process that advances based on the material and economic foundations of society. This materialist perspective is well suited to the unravelling of socio-technical transformations and antagonisms because technologies always have unique material foundations and specific material impacts.

The key idea of future-oriented dialectics is, in principle, simple: An evolving societal trajectory always unravels its own counter-trajectories. Within this perspective, the future is perceived to emerge as a space of potentialities with varied tensed and parallel dynamics. Dialectical futures research perceives future-oriented phenomena via the lenses of tensions and contradictions: Phenomena can be oppositional and antagonistic, but they can also be generative, that is, they open up new possibilities.

There are conceptualisations of dialectics in the context of futures research that provide solid starting points for my exercise (see, e.g., Dolan, 2018; Funtowicz & Ravetz, 1994; Luukkanen, 2017). I discuss two of these here. First, I briefly present an intriguing analysis of emerging complex systems by Funtowicz and Ravetz (1994), who argue that emergent complexity is a process that "oscillates between hegemony and fragmentation" (p. 568), with fragmentation referring to "a conflict among plural attempted hegemonies" (p. 571). The emergent complex system is in a dialectical state of tension – or contradiction – between the monolithic hegemonic configuration and the pluralistic diversity that challenges it. If the hegemonic configuration in a society is aimed at suppressing tensions and contradictions, they could implode into a conflict between various alternative configurations, potentially leading to a collapse of the entire system. Funtowicz and Ravetz (p. 569) argue forcefully that the "full analysis of emergent complexity" calls for a dialectical approach and that this kind of analysis requires an understanding of "several sorts" of contradictions (p. 573). They provide three aspects of the notion of contradiction: (1) complementarity: a balance between the "opposed elements"; (2) destructive conflict: a struggle between opposites collapses "the system in which they coexist" and (3) creative tension: resolution through "qualitative transformation of the system," that is, a Hegelian synthesis (p. 573). The approach is a useful account for the purposes of this paper. However, I aim to advance the argument by providing a more nuanced and explicitly future-oriented conceptualisation of dialectical positions and dialectical processes.

A second conceptualisation, which is also useful from the perspective of this paper, is the transformative cycle described by Slaughter, Naismith and Houghton (2004). In this cycle, there are four stages. The first stage deals with breakdowns of meaning, that is, changes that transform conceptions of social interaction and the structural problematic. The second stage has to do with reconceptualisations, whereby new interpretations of social interaction emerge. The third stage comprises negotiations and conflicts. In this stage, the new interpretations from the second stage are confronted by the interpretations of those in power. These actors endeavour to preserve the status quo because this particular order has granted them a powerful position. The fourth stage is selective legitimisation; here, certain interpretations of change begin to obtain societal legitimacy and become part of societal activities.

Dialectical thinking has also been conceptualised by varied philosophers and social scientists: One can speak of a variety of dialectics. Some notable variations from the perspective of this paper include dialectical materialism (Lefebvre, 2009); dialectics of duration (Bachelard, 2000); anticipatory consciousness and dialectics of utopia (Bloch, 1986); contradictions and determination (Althusser, 1967; Castán Broto, 2015); socio-spatial dialectics and trialectics of spatiality, sociality and temporality (Soja, 1980, 1996);

historical-geographical materialism (Harvey, 1982); spatial dialectics (Halvorsen, 2017; Jameson, 2010; Sheppard, 2008); potentiality and virtuality as dialectical concepts (Meillassoux, 2011) and plasticity in understanding the future as a dialectical process (Malabou, 2000). Obviously, none of these variations can be fully discussed in the space of a single paper. In the next section, I present selected varieties that have particular relevance for this paper.

## 2.2. Three varieties of dialectics

The starting point for dialectics is a constellation in which two processes, phenomena and/or arguments are set in tense interaction (Fig. 1). The classic “Hegelian model” adds a third component to this scheme: thesis, antithesis and synthesis (Lefebvre, 2009, p. 19). Here, I depict three varieties of dialectics that I perceive as beneficial in constructing a distinctively future-oriented dialectical approach. I term these approaches (1) trialectics, (2) creative societal tensions and (3) generative contradictions.

First, in a trialectical approach, the basic dialectical duality of a thesis and anti-thesis is set in a specific socio-spatial context. *Trialectics* mean that societal processes are simultaneously deciphered from historical, social and spatial perspectives (Soja, 1996). Following Lefebvre’s (1991) classic formulation, trialectics focus on three spatial interpretations: lived space, perceived space and conceived space (Soja, 1996, p. 70). Soja (p. 61) argues that the “thirthing” of dialectics – by paying attention to the spatial and material contexts of the dialectical process – leads to a reconstitution of dialectics and the unravelling of alternative societal options. This opening of alternatives, set in a particular spatial context, is a fruitful practice in terms of building future-oriented dialectics.

The second relevant dialectical variant perceives dialectics as *creative societal tensions*. The potential of dialectical thinking lies in the structure of tension itself: Contradiction can be understood as a possibility for transformation, not as a locked situation. As Lefebvre (2008) puts it, contradictions are creative moments: “contradictions give rise to problems, and thus to a set of possibilities and to the need to find a solution, and therefore to the need to make a choice.” In Lefebvre’s (2009) thinking, the negativity of dialectical thought, that is, the identification of the anti-thesis, should be perceived as a creative power (p. 21). Accordingly, the anti-thesis “negates, makes manifest and completes the first term, by expressing its one-sidedness” (pp. 21–22). It is important to identify the point at which continuity evolves into discontinuity and “quality has reached its immanent limit, urged on ... by quantitative changes” (p. 32).

Dialectical thinking and practice can lead to shifts in prevailing circumstances and beliefs and, hence, be a source of societal transformation. This notion is the basis of the third variant, *generative contradictions*, as suggested by Castán Broto (Castán Broto, 2015). Within this frame, societal contradictions are not understood merely as negations but as creative potential based on “utopian attempts to transform the world and the need to implement such attempts in practice” (p. 461). Contradiction is a “generative force inherent to the struggle to make utopian aspirations operative” (pp. 461–462). Castán Broto perceives the contradictory components (thesis–anti-thesis) not as ostracising blocks but as complementary parts that define one another (p. 462). Her approach resonates with that of Althusser (1967): “the ‘contradiction’ is inseparable from the total structure of the social body in which it is found, inseparable from its formal conditions of existence, even from the instances it governs.” However, Castán Broto’s (2015) approach emphasises the role of societal action more so than that of Althusser: Action is based on the identification of the specific circumstances that have produced the contradiction (p. 462).

## 2.3. A fourth variation

The fourth variation could be called *future-oriented dialectics*, the approach I develop in this paper. There are three core ideas that condition this variation, the first of which is common to all forms of dialectical thinking, that is, a commitment to the world as a process and a becoming. As Benson (1977) aptly puts it,

A dialectical view is fundamentally committed to the concept of process. The social world is in a continuous state of becoming—social arrangements which seem fixed and permanent are temporary, arbitrary patterns and any observed social pattern are regarded as one among many possibilities.... Dialectical analysis involves a search for fundamental principles which account for the emergence and dissolution of specific social orders. (p. 3).

The second idea is the focus on societal, or socio-technical, trajectories and the various dynamics of these trajectories. Here, trajectory can be quite broadly defined as referring to various societal and socio-technical processes and development tendencies that can be identified from, and followed in, a societal setting characterised by relative coherence. Thus, there should be an identifiable and followable core to the trajectory, be it a societal tendency or technological development path. In interpreting the dynamics of trajectories, I follow Ernesto Laclau’s and Chantal Mouffe’s theorisation of antagonism, especially the notion of heterogeneity (e.g. Laclau, 2006). The interpretation also builds on Žižek’s (2006) notion of “parallax gap.”

The third idea of future-oriented dialectics is that it is based on systems and complexity thinking, particularly on the idea of a

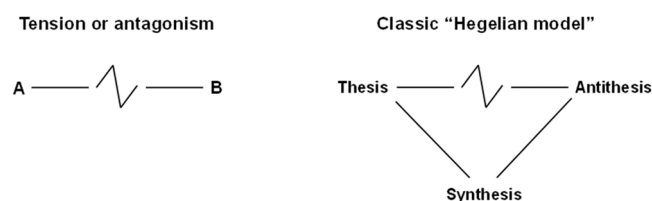


Fig. 1. Basic outline of the dialectical approach.

societal system consisting of various parallel and contradictory trajectories, for example, technological trajectories (e.g., Castellacci, 2008; Dosi, 1982), knowledge trajectories (e.g. Nomaler & Verspagen, 2016), local or regional development trajectories (e.g., Crescenzi & Iammarino, 2017; Dunford & Smith, 2000; Ettliger, 1999), business growth trajectories (e.g., Skuras et al., 2005) and so on. The focus of future-oriented dialectics, as I depict here, is to study the future-oriented dynamics of the trajectories in a societal system (on future-oriented dynamics, see, e.g., Dufva & Ahlqvist, 2015; on social systems, see, e.g., Gren & Zierhofer, 2003; Luhmann, 1977, 1990, 2006; Viskovatoff, 1999).

I argue that there are two key elements in future-oriented dialectics: dialectical positionality and dialectical processuality. Dialectical processuality can be further broken down into trajectory- and system-level dynamics. I discuss all of these in turn.

### 3. Future-oriented dialectics: Positions and processes

#### 3.1. Dialectical positionality

Dialectical positionality refers to basic dialectical positions as the outcomes of the dynamics between the spatio-temporal and socio-technical trajectories in the societal system. The key idea combining positions and processuality at both the trajectory and system levels (see next sections) is that the various positions can be both results and outcomes of trajectory dynamics. Hence, there is no necessary determinism between the types of trajectory dynamics and positions, but their connections are always contextual and case-specific. It is possible for various positions to shift in particular ways while the trajectory dynamics traverse in spacetime. It means, for example, that contradiction can turn into conflict, or tension can turn into antagonism and vice versa. It is also possible for the system-level dynamics resulting from various trajectory-level dynamics to build into dialectical positions that spring from systemic interactions.

Dialectical positions can be scrutinised through the specific concepts depicted in Table 1. The basic dialectical position is *contradiction*, which goes back to Hegel's notions of thesis and anti-thesis and the basic contradictions of the capitalist system, such as the contradiction between exchange value and use value (see Harvey, 2014; Stahel, 1999) and the contradictions of the state's spatial governance (see Ahlqvist & Sirviö, 2019). In futures studies, contradiction refers to the key characteristics of any future trends and wider societal development trajectories. Contradiction can be resolved; that is, the thesis and anti-thesis can be integrated into a synthesis that further takes the position of a new thesis that is then challenged and so on.

In future-oriented dialectics, *tension* refers to a frictional position of two or more societal elements or trajectories that have the potential to develop towards antagonism and then be resolved through synthesis or dissolution. From the perspective of futures research, tension is like an emerging issue that can develop into various future directions.

*Antagonism*, then, refers to a more primary juxtaposition of two societal elements or trajectories. A classic theory of antagonism is Schmitt's (2007) conceptualisation of politics as based on the distinction between friend and enemy. Schmitt argues that all political activities are based on crafting distinctions: between us and them, same and other, familiar and foreign and so on. However, here, the notion is based on Laclau's (2006) theory of antagonism as a limit to objectivity that constitutes both parties involved in an antagonistic relation. Laclau (p. 104) argues that "from the viewpoint of each of the two antagonistic forces, its opponent is not an objective presence, completing the fullness of one's own identity, but represents, on the contrary, that which makes impossible reaching such a fullness." As formulated by Thomassen (2005), antagonism refers to the formation of "system of differences" to "oppose an external threat". It can consequently be argued that this system, in order to oppose something consistently, needs to operate within a singular ontological domain.

A key concept used by Laclau (2006) in the context of antagonisms is heterogeneity, which implies a radical difference existing inside a space of representation. Thomassen (2005) defined Laclau's notion of heterogeneity as referring to an "excess escaping the attempt to discursively objectify the boundaries of identities." Heterogeneity in a societal system is a constructive source of diversity that invariably destabilises the antagonistic relation and constantly pushes it on the verge of mutation or conflict. What is particularly important from the perspective of future-oriented dialectics is that heterogeneity keeps the antagonistic relation, and the antagonistic trajectory, open to different change impulses from various societal fields. As I have argued above, antagonism usually exists in a

**Table 1**  
Key positional concepts in future-oriented dialectics.

Concept	Theoretical orientations and meanings
Contradiction	Contradiction is a generic dialectical concept that refers to inherent polarities of societal tendencies and societal forces that, from the dialectical perspective, are the core components of development in a societal system.
Tension	Tension refers to a process in which two or more societal elements or trajectories are in a frictional position so that their further development could increase or decrease the friction. Tension could develop towards full-blown antagonism.
Antagonism	Antagonism is a more radical version of tension (a more unstable and active than opposition) in which societal elements are pitted against each other, so that this juxtaposition causes confrontation, struggle and conflict. Antagonism is founded on a singular ontological domain and could advance toward disintegration or integration. Antagonism could also lead toward a parallax gap (see below).
Opposition	Opposition is based more on like juxtaposition than antagonism, but it is more stable and passive and does not necessarily lead to confrontation. Opposite elements could also co-operate with each other on certain issues.
Conflict	A struggle or confrontation that is a possible outcome of contradiction or antagonism.
Positional parallax gap	A "parallax gap" is a concept that refers to a fundamental difference between two societal perspectives that are simultaneously connected by a setting yet unresolvable as such. From the perspective of future-oriented dialectics, the notion refers to an "unresolvable antagonism" based either on a fundamental duality or on differing ontological domains.

singular ontological domain, that is, the elements in an antagonistic relation share an ontological ground and hence there exists a continuous open possibility for further distintegration or integration. This possibility is based on heterogeneity. The notion enables the study of dialectical relations in multiple societal and socio-technical trajectories as they move in time and space. In futures research, the concept the antagonism can be treated as two elements or trajectories that ostracise each other's activities or even existence.

We could also define a somewhat "milder" form of antagonism as *opposition*, in which the elements or trajectories are in an antagonistic relation, although in a sort of passive locked-in antagonistic relation that still enables co-operation on some issues. However, the opposition used in the context of future-oriented dialectics should be separated from the Kantian notion of "real opposition" – an opposition between physical objects – which is also discussed by Laclau (2006).

*Conflict*, again, would be an active confrontation or struggle that could result from contradiction or antagonism. The confrontation could be based on multiple causes, such as differing ontological or epistemic perspectives or on diverging views about societal practices. The conflict is, by its nature, a more or less temporary position that is usually resolved by the means of dialectical trajectory dynamics, such as synthesis or absorption (see Fig. 3). The conflict could also stay unresolvable for some time: then it remains in an antagonistic position or develops towards a parallax gap.

A kind of fundamental antagonism was coined through Žižek's (2006) *parallax gap* notion. According to Žižek (p. 17), the parallax is "the apparent displacement of an object (the shift of its position against a background), caused by a change in observational position that provides a new line of sight." The parallax is based on an antagonism between two profoundly differing perspectives. Žižek (p. 4) notes that a "parallax view" refers to a "constantly shifting perspective between two points between which no synthesis or mediation is possible"; however, these points are still connected like "opposed sides of a Moebius strip." This formulation refers to a duality in which an entity is composed of two fundamentally differing qualities. According to Secor (2008), Žižek's parallaxes are based on two impossible perspectives that do not share ground or language. A parallax does not refer to "the difference between two positively existing objects, but difference 'as such'" (p. 2624). The question, therefore, is about difference that does not enable a Hegelian synthesis. Žižek (2006) mentions three parallax gaps of this kind. The first is the ontological gap, that is, differences between people's conceptions of reality. The second is the scientific gap between experimental reality and its scientific explanation. The third is the

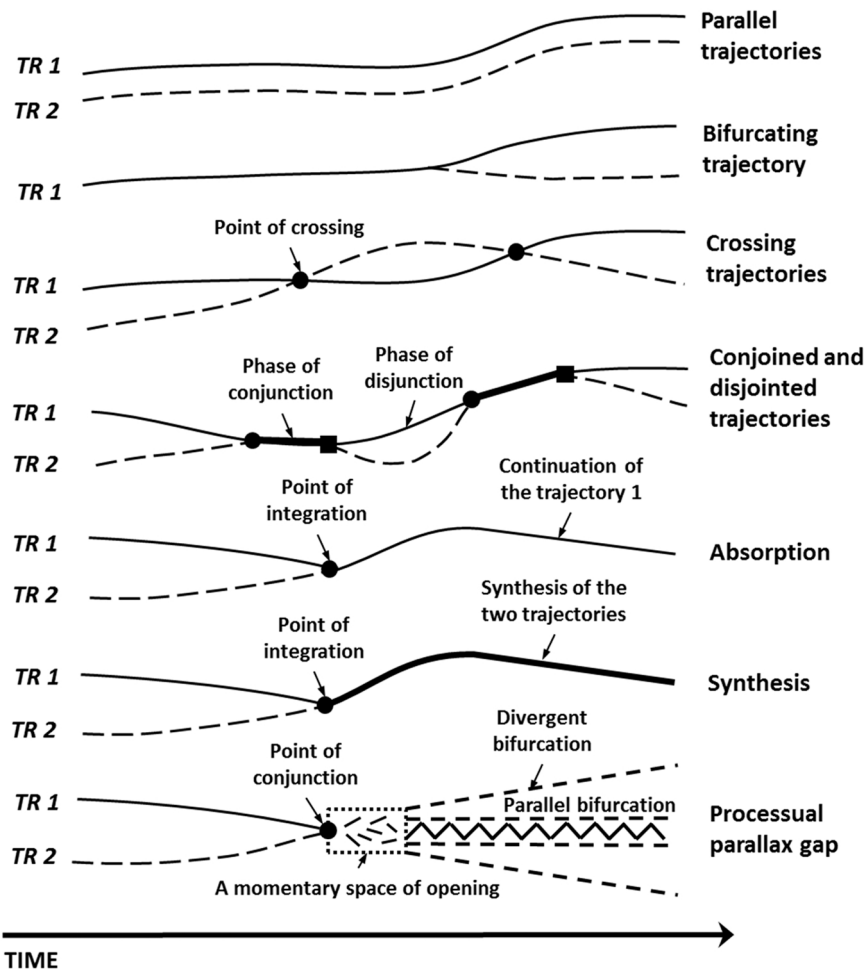


Fig. 2. Processes in future-oriented dialectics, part 1: Examples of trajectory dynamics in a societal system.

political gap, that is, a non-resolvable societal antagonism between the actors in a conflict (p. 10). Summing up, the basic departure between the parallax gap and antagonism is that parallax gap is either based on a fundamental duality or on an ontological difference as the antagonism is operating within a singular ontological domain. Basically, the fundamental duality cannot be resolved, but it can be explained by referring to other dualistic elements. The ontological difference cannot be resolved, because the elements in parallaxic relation exist in different ontological domains causing a constitutive distinction in the worldviews. These two aspects of the parallax gap also make the integration of elements impossible, when in the case of antagonism there exists an open possibility for further disintegration or integration based on heterogeneity, an inherent excess produced in the social process.

It is crucial to acknowledge that antagonism and the parallax gap have a somewhat shared ground in the sense that they are both dialectical positions that cannot be resolved via direct synthesis, but both positions always require “processual work” that move the elements either towards disintegration or integration. However, I see that their primary difference, and why they should both be included in the framework of future-oriented dialectics, is that antagonism is built from plural and heterogeneous elements, and is more open to change, but the parallax gap is more of a fundamental antagonistic position that cannot be resolved without drastic change in perspectives and ontological domains.

3.2. Dialectical processuality I: Trajectory dynamics

Dialectical processuality refers to the processual nature of future-oriented dialectics, that is, the unravelling of the spatio-temporal processes and socio-technical trajectories that characterise the changing societal system. Processuality here refers to a longitudinal temporal process that can be measured against a certain time-frame, for example, the temporal evolution of a system. Dynamics refer to the activities of and between the components of a system, such as its relations and feedback loops. Thus, the dynamics can be tracked by analysing and visualising the changing configuration of the system. Both of these concepts refer, more or less, to the same idea (the

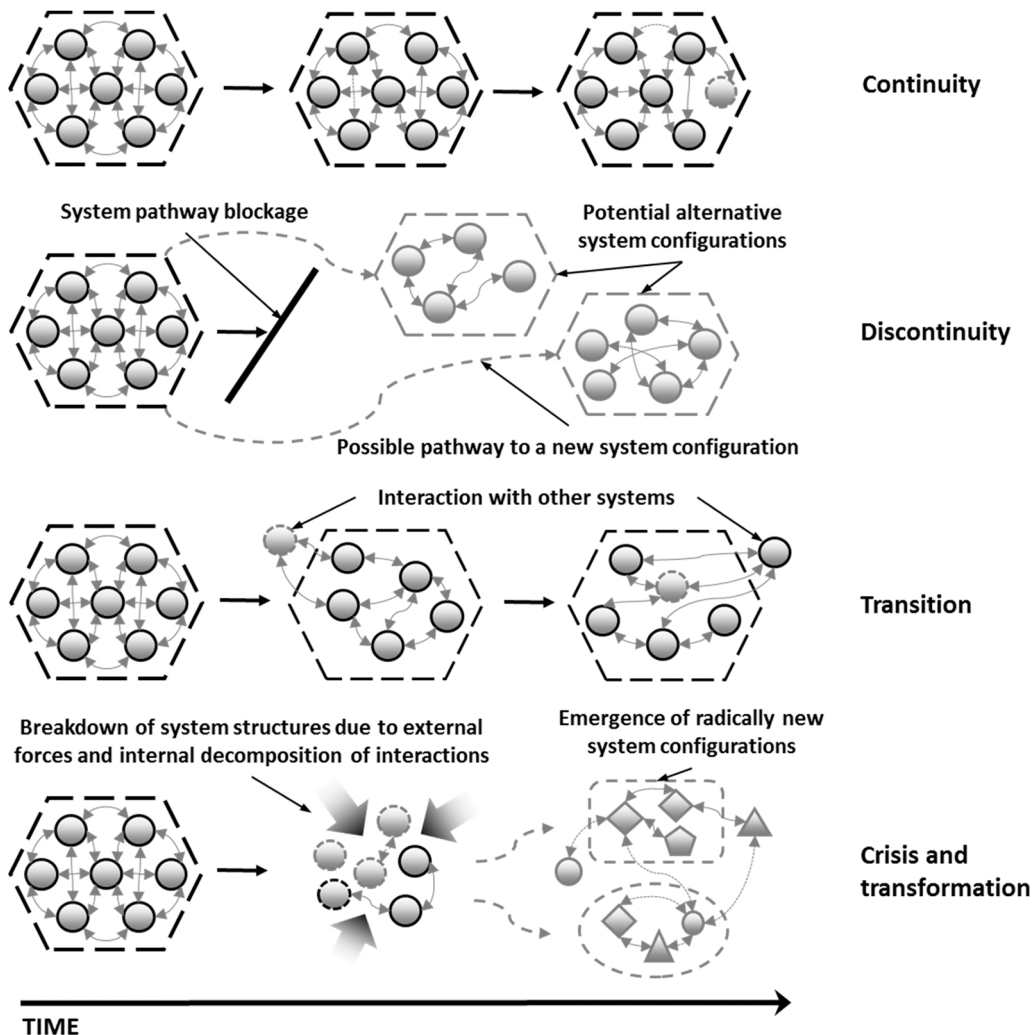


Fig. 3. Processes in future-oriented dialectics, part 2: Examples of system-level configurations.

evolution of system); it is the perspective and the scale that differ.

Here, I make a distinction between trajectory-level processual concepts (Fig. 2) and system-level configurational concepts (Fig. 3). The trajectory and system levels can be perceived as two sides of the same processuality. Trajectories refer to processes that are contextual and case-specific; they are also predominantly located at the micro-level or meso-level. The system level is, as the title suggests, a synthesising systemic account of various trajectory dynamics in a domain. The processual perspective shares a conceptual vicinity with various complexity theorisations in the social sciences (see, e.g., Urry, 2005), futures studies (see, e.g., Derbyshire, 2016) and socio-technical transition frameworks, such as multi-level perspective (e.g., Geels, 2012).

Here, I also depict stylised examples of positions and trajectory dynamics (see Fig. 2). These examples are not meant to be read as systematic case studies but as potential directions that could be worthy of contemplation and systematic analyses. This paper is meant to provide a theoretical outline and starting point for the further analysis of future-oriented dialectical processes and positions. Therefore, in the meagre space of a single paper, it is not possible to present several systematic case studies.

First, societal trajectories could be *parallel*, that is, simultaneously advancing trajectories that have more or less the same kind of societal vision or target. The parallel trajectories in Fig. 2 could depict a situation in which, for example, socio-economic trends align or a situation in an industrial value network where subcontractor companies follow the actions of a core locomotive company. Parallel trajectories thus depict a sort of “normalised” societal position in which there are dominant trajectories that are then seamlessly followed by subordinate trajectories. Depending on the positions, the dominant trajectories could occasionally change order, or new trajectories could emerge, as in the emergence of new technologies that could overhaul previously dominant trajectories.

Second, a trajectory could go through a *bifurcation*. In systems theory, bifurcation refers to a branch in which a single development trajectory splits into two directions. Here, I utilise bifurcation in a systems theoretical sense to depict a trajectorial split where a singular trajectory divides into two or more trajectories. Bifurcation is a process, a dynamic set of events that can result in a two or more trajectories that can be in various positional relations (e.g., tension, antagonism, opposition, conflict, parallax gap) with one another. Because bifurcations are dynamic their positions could also evolve when the process unfolds. I illustrate this with stylised technological examples. The development of technologies is based on bifurcation in multiple senses: Technologies can be utilised for several, often contradictory, purposes. The socio-technical tensions that arise as technologies are utilised could also lead to the formation of antagonism. An obvious example of this is nuclear technology, which has simultaneously enabled a method of producing energy and a weapon of mass destruction. A second example is biotechnology, which opens up possibilities for the development of efficient medicine and sustainable bioeconomy solutions but simultaneously creates novel bio-risks.

Here I present two further examples of bifurcation. The first is the dual use of emerging technologies in the context of synthetic biology. Rabinow and Bennett (2012) argue that dual use is particularly risky in this context. They assert that some researchers in the field of synthetic biology want to distanciate themselves from the dual use problematique by emphasising the notion that research is always performed with “good intentions” (p. 147). For Rabinow and Bennett, this position means that ethical dilemmas are removed from the core of the research praxis and transferred to specialists, such as professional ethicists or lawyers. This rhetorical strategy, however, does not remove the dialectical tension caused by dual use but distanciates and relocates it. According to Rabinow and Bennett (p. 148), one consequence of this distanciation is that researchers of synthetic biology fail to consider the ethical impacts of their practice, thereby furthering the immediate tension towards antagonism and conflict.

The second example of bifurcation is the emergence of touchscreens in the mobile phone industry. There is a common narrative that the Finnish phone company Nokia could have had a first prototype version of touchscreen phones by 2004. In a popular *New York Times* article, O’Brien (2010) depicts an event in which Nokia’s research engineers “demonstrated to business customers at Nokia’s headquarters” a prototype for “an Internet-ready, touch-screen handset with a large display.” The article interestingly implies that the chance to popularise the touchscreen – commonly proposed as a crucial step in the pathway leading to the downfall of Nokia’s mobile phone production – existed years before the rise of Apple’s iPhones. Nokia’s management then made the decision to abandon the technology. In 2004, the full spectrum of possibilities for this technology could not have been foreseen, prompting management to assess it as a potentially risky investment. With the benefit of hindsight, this temporal point could be perceived as the building of tension, or even a contradiction, between the chosen and abandoned trajectories and the potential trajectory that could have opened the door to an alternative future for the company.

Third, trajectories could be *crossing* in various ways: trends could cross and have different kinds of impacts on one another. There are several examples that could be iterated here: a crossing could happen in an organisational or spatial setting, such as a working group or meeting. In such crossings, various types of information are exchanged and could have various repercussions. Another crossing could be a specific event, such as a workshop or seminar, in which people from different organisations gather, which could lead to the exchange of various types of information that could, then, interact and create surprising feedback loops in the system, such as joint projects between competing companies. Crossings could be pinnacles to various dialectical positions, such as tensions and antagonisms, but are rarely the mere causes of these positions.

Fourth, trajectories could be momentarily *conjoined* at some parts, thereafter becoming *disjointed* and then conjoined again. The phase of conjunction could result in moments of more long-term crossings, such as collaborative projects or stages of technology development where some key technological paths converge. In these conjunctions, multiple dialectical positions could be represented, such as tensions, antagonisms or even conflicts. Nonetheless, these positions are rarely outcomes of just these conjunctions; they may also be affected by the dynamics of disjunctive phases.

Fifth, *absorption* refers to a process in which “two temporal paths integrate in such a way that the other becomes a part of the more dominant trajectory, and finally is embedded in it” (Ahlqvist & Rhisiart, 2015, p. 100). Absorption could also refer to a blockage of a societal trajectory by another trajectory; practically the result is similar in both cases. This kind of process could happen, for example, when a company makes a strategic decision to buy another company. In this case, the activities of the purchased company could either

continue or be disrupted, albeit in the context of the buying company. This is usually the case with potentially overlapping corporate functions, such as accounting or marketing. This new trajectory catalyses various contradictions, for example, between the differing corporate cultures in general and between the overlapping functions in particular. The absorption could catalyse antagonisms, that is, the formation of negation to the dominant trajectory, which could “haunt” the corporate culture far into the future.

Sixth is the *synthesis*, a basic dynamic of dialectics in which theses and anti-theses can integrate and form new thesis and so on. The synthesis could foster antagonisms that condition the trajectory. An example of this could be practices in the Western liberal political system that are aimed at building participation and social inclusion. Mouffe (2005) highlights that in liberal societies, antagonism becomes the fundamental denominator of political activity. Liberal politics unravel as a quest for expert-based consensus built on rational conversation. Mouffe argues that, fundamentally, this kind of conversation is a depoliticising practice that dilutes politics via practices that label certain ideas as rational and some as irrational (p. 123). The liberal idea of rational conversation is revealed as a political activity based on the concealment of antagonisms. Therefore, the political is not actualised in the sphere of “rational conversation” but in the practices that exclude deviant perspectives from this conversation. This is also how liberal technology-mediated society operates. For example, multiple policy and planning processes are currently amended with technological solutions that encourage citizen participation and, thus, are open to societal heterogeneity (see Laclau, 2006; Thomassen, 2005). However, in many cases, alternative viewpoints are ultimately excluded, and actual political decisions are the product of hegemonic power structures (see Ahlqvist & Rhisiart, 2015, p. 102).

The seventh and final trajectory-level concept is the *processual parallax gap*. From the viewpoint of dialectical processes, the parallax refers to “a fundamental branching of temporal paths” (Ahlqvist & Rhisiart, 2015, p. 99). This branching could have two results: bifurcation towards different directions or locking into a parallel position (p. 99). In either case, the process does not enable a synthesis.

In dialectical futures research, the notion of the parallax can be used in the scrutiny of futures pathways and their bifurcations (see Ahlqvist & Rhisiart, 2015). This bifurcation is the result of three inherent aspects of social processes. First, societal activities are continuously embedded in varied societal contexts, thereby causing tensions. Second, societal activities are habitually set against other activities, and these relationships can take co-operational, antagonistic or conflictual directions. Third, societal activities are invariably performed only partially; that is, the actual realisation does not fully comport with how the activities are depicted. This means that societal activities catalyse the formation of residual spaces and openings in social structures that are potential sources of tensions. As such, there are at least two possible outcomes of parallaxes. In the first instance, the parallax acts as a wedge that breaks the pathway into two or more paths that then evolve into various directions. In the second instance, the parallax locks the pathways into an unresolvable thesis–anti-thesis antagonism that cannot be merged into a synthesis. Even if these pathways were artificially integrated, the structure formed would carry traces of these opposing positions and would be a potent source of instability.

For the seventh example, I present a more extensive case: a positional parallax gap formed through the research field of synthetic biology and its potential impacts on society. Synthetic biology is a wide-ranging concept that integrates several synonyms, such as constructive biology, intentional biology, biological engineering and synthetic genomics (Balmer & Martin, 2008, p. 6). Synthetic biology involves the intentional planning of biological systems and living organisms by applying engineering principles (e.g. Balmer & Martin, 2008; Cserer & Seiringer, 2009; Kastenhofer, 2013). It is a hybrid that combines the approaches of the natural and engineering sciences in order to produce new biomolecular components and synthetic organisms (Andrianantoandro, et al., 2006). The basic goals of synthetic biology are to produce minimal genomes, plan biological parts in order to build larger components, construct artificial cells and create synthetic biomolecules (Balmer & Martin, 2008). Its “value promise” is based on visions of cheaper drugs, new bio-based fuels and precision solutions for health care. In depictions of synthetic biology, it is common to use the terminology of the engineering sciences, even though some researchers see this as problematic. Boudry and Pogliucci (2013, p. 666) assert that the more biologists use metaphors such as “machine” and “engineering,” the more something essential is lost in terms of biological understanding. Erickson, Singh and Winters (2011, p. 1254) further observe that strong analogies between synthetic biology and engineering can lead the public discussions in the wrong direction.

In the field of synthetic biology, the prime breakthrough has been the emergence of CRISPR-Cas9 (clustered regularly interspaced palindromic repeats) technology, that is, enzyme-based “genetic scissors.” In the 2010’s, CRISPR-Cas9 spread swiftly across the global “labscape” because it proved to be easy-to-use, cheap, precise and an effective tool with which to manipulate the genome. Doudna and Charpentier (2014) envision that, in the future, CRISPR could be applied in multiple solutions and across different contexts, such as medical testing, the control of ecological vectors (such as the sterilisation of mosquitoes) and the development of varied species. The emergence of CRISPR-Cas9 has generated debate about how to undertake genetic modification in the future. One example of this debate is the discussion surrounding the use of CRISPR-Cas9 as a gene drive, whereby specific genetic transformations can be driven through an entire population of species. Gene drives can be applied, for example, in the modification of the genome of mosquitoes in order to extinguish malaria, to raise the pesticide tolerance of plants or exterminate local pest species (Oye et al., 2014). The problem with gene drives is that researchers do not have a clear picture of the consequences of the spreading of the modified genetic material. Key questions are as follows: How will the modified material behave in nature? Could it spread to other species than the target species? What are the long-term consequences (Oye et al., 2014, p. 627)?

The hybrid basis of synthetic biology has catalysed a parallax in which the perspectives on these practices have bifurcated in two antagonistic directions: proponents representing a sort of techno-deterministic engineering biology and opponents representing a traditionalist–environmentalist perspective, a “sacred life” discourse. The engineering perspective emphasises biology through the lenses of the engineering sciences: Biological material is understood as whatever material that can be moulded and manipulated with the instruments of engineering sciences. The traditionalist–environmentalist perspective is founded on a sort of “sacred life” view that perceives life as a delicate structure constructed through the long passage of evolution. In this perspective, life is perceived as an



axiomatically inviolable principle, and thus, tampering with it is seen as risky business. This perspective is exemplified by SynBio-Watch, a citizen movement started at the University of Berkeley, California, which aims to construct critical perspectives on synthetic biology based on societal and ethical viewpoints (<http://www.synbiowatch.org/about-synbiowatch/>). Synthetic biology can be thought of as a prime example of a parallax: Its societal dialectic is crystallised in an antagonism between two foundationally differing socio-technical perspectives.

### 3.3. Dialectical processuality II: System-level dynamics

The various trajectory-level dynamics discussed above result in system-level dynamics that can be depicted through four system-level configurations (Fig. 3). Here, I take a system to be the outcome of, and a context for, multiple trajectory dynamics (see above). I would like to emphasise that these configurations are meant to be heuristic frames that rarely exist as such in the “actual” empirical world. Hence, one will rarely locate a societal system that is, for example, “purely” continuous or discontinuous. Instead, these configurations depict ideal types of dialectical processes that can be analysed in specific forms in different contexts.

The system level is important in future-oriented dialectics because the societal system has multiple roles in the context of dialectical positions. First, the societal system is a catalytic source of varied dialectical positions, such as contradictions between hegemonic systemic practice and its alternatives (see Funtowicz & Ravetz, 1994), tensions between various technological trajectories and potential antagonisms between, for example, political ideologies or religious perceptions. Second, the societal system is a mechanism of internalisation of various dialectical positions and for fostering continuities in the societal system. Third, the societal system is a configuration with a significant function in enacting necessary societal changes in a legitimate and “non-disruptive” fashion. This function is realised through democratic means by enabling citizens to participate in decision-making, ensuring the necessary legal frameworks and concomitant guardian functions and, thus, acting as a relevant systemic cushion towards “overly disruptive” political perspectives and practices.

Here, I present a few significantly stylised examples of system-level dynamics of dialectical processes (see Fig. 3). The examples are meant to provide basic insights into system-level dynamics from the perspective of future-oriented dialectics, but I point out that they should only be taken as indicative potentials for further analysis and exploration. These configurations usually exist simultaneously in a societal setting, as discussed above. This is particularly the case with continuities and discontinuities as well as transitions. As I argue, crises and transformations are, eventually, rare and fractural processes, and by definition, they pave the way for novel societal components and structures.

The first processual system configuration is *continuity*, which refers to a relatively stable period of societal system development, that is, the societal logic and trajectories remain stable for a long period of time (Fig. 3). Continuity implies relative trajectorial stability based on several continual social processes, such as worldviews, epistemic assumptions, repetition, routines and different conserving processes with systemic feedback loops. During continuity, these continual processes could undergo incremental changes, such as changes in interaction dynamics or even slight changes in actor settings, but the system configuration itself, its elements and logic, remains stable.

Continual processes are fundamental features in any societal and socio-technical system. They include various processes stemming from the construction of belief systems, such as religions, worldview-constructing philosophies and political ideologies. They include various forms of repetition and mundane routines on which societies are based. There are multiple examples of repetitive practices, such as events based on calendar time and the ensuing separation between working time and leisure time; wider societal events for keeping up society and organisations, such as elections; various forms of reporting and so on (see, e.g., Stahel, 1999). There are also myriad mundane routines in the lives of organisations and individuals that keep up the appearance of continuity in the societal system. These range from organisational planning, meetings and interactions to the daily lives of individuals, including working and leisure life, family life and so on. Continuity could also refer to societal and spatial divisions of labour in a societal system such as the nation-state (see, e.g., Massey, 2007).

What is notable when it comes to continual configuration is that, despite the label, there are on-going processes of emergent variances in societal processes and practices. In industrial and corporate settings, these kinds of mutations are deemed incremental, that is, changes that alter the practices and products only slightly and within existing domains. Thus, what is crucial in the case of continuity is that the changes emerging in the trajectory dynamics are of a kind that remain within the sphere of the existing system, and these dynamics do not express inclinations of breaking out of the existing domain.

The second configuration is *discontinuity*, which refers to a relatively sudden rupture in societal processes with broad impacts on the trajectories of a societal system. Discontinuity is a systemic unfurling due to a system pathway blockage that catalyses the envisioning of alternative system configurations, but these visions do not necessarily lead to full-blown crisis and transformation in the system. When the system again reaches its operational balance after this unfurling, it could (1) return to the previous system configuration; (2) move towards a transition stage or (3) advance towards a crisis and radical transformation pathway (see below). The notion of discontinuity resonates with the theory of disruptive innovation (see, e.g., Christensen et al., 2018). However, in future-oriented dialectics, the perspective is particularly on par with the societal system, not on those of singular innovation or business ecosystems.

In future-oriented dialectics, discontinuity refers to a temporary blockage of the system, after which the system either returns to the continuity stage or advances towards a transition or even a crisis and transformation stage. An example of a blockage could be the generic societal perspective towards a fossil-based economy, which has become a practical blockage for multiple actors. In a discontinuous setting, the system enters an unbalanced configuration that catalyses the envisioning of novel and possible pathways towards alternative system configurations. There are also several examples of discontinuities in industry, where innovation activities catalyse processes of change that result in imaginaries, sometimes realisations, of alternative system configurations (see, e.g.,

Christensen et al., 2018). Hence, the novel practices catalysed by innovations form a blockage to the dominant pathway that unravels alternative visions. When the process is repeated several times and within a necessary long-term horizon, some of these novel pathways will eventually materialise and lead towards a reconfiguration of the system. It is crucial to realise that in an empirically verifiable system, there are always multiple ongoing, parallel processes of continuities, discontinuities and even transitions and that these processes bear unique context-specific features.

The third configuration is *transition*, which refers to a relatively long-term change of the societal system in multiple parallel trajectories and fronts that move towards a novel type of system configuration. The transition could result from a discontinuity and the envisioning of novel system pathways as well as from the complex interaction of various system elements, the interactions and processes in the system or between the interactions and processes of two or multiple neighbouring systems. The notion of transition utilised here resonates with the wide-ranging literature on transition theories under such concepts as “sustainability transitions” (e.g., Markard et al., 2012; Smith et al., 2012) and “socio-technical transitions” (e.g., Smith et al., 2005; Geels, 2012) and the notion of systemic and non-linear causes of transitions (see, e.g., Geels, 2007). However, the notion of transition in these theories seems to denote a generic change, or even a transformation, that could proceed by combining new system components with the already existing system components. The difference between this notion and the notion of transition in future-oriented dialectics is that here the transition is defined precisely as a change in the system configuration of existing system components. In future-oriented dialectics, transition refers to a relatively smooth but inevitable change of existing interactions towards novel configurations that still bear the remnants of the earlier system. Thus, the transition is not a radical rupture that dismantles existing societal structures and elements; it is more of a lucid and mellow change that is primarily due to interactions between societal systems in different domains.

An example of a transition could be the above-mentioned change in the fossil-based system in the context of a legitimate regulative framework in a societal system. Another example of a wide-ranging transition is the process of societal digitalisation, which simultaneously combines continuous, discontinuous and transitional features. The transition could also be more domain-specific, such as a transition in the energy system towards a smart grid system or the transition of health services towards more personalised and do-it-yourself types of practices.

The fourth configuration, *crisis and transformation*, denotes the radical change in the system, in which crisis precedes the fundamental reconfiguration, or transformation, of the system. From a processual dialectic perspective, crisis is an outcome of multiple simultaneous antagonisms, conflicts and discontinuities in the societal system (for different theoretical insights on system-level crises, see, e.g., Chorev & Babb, 2009; Jessop, 2015; Larner, 2011). Crisis induces a breakdown of system structures due to external forces, which leads to the internal decomposition of systemic interactions and system elements. Here, crisis unravels possibilities for system transformation that refers to a fundamental change of the system and an emergence of radically new system structures, elements and system logic (on the transformation and dialectics, see, e.g., Ahlqvist & Sirviö, 2019; on policies and crisis, see Peck, 2011).

In the context of future-oriented dialectics, transformation refers to an ensemble of abrupt wide-ranging changes and ruptures that break down existing systemic structures and catalyses the formation of radically new system configurations. Usually, the crisis is induced by simultaneous external forces that affect the system and the internal system dynamics that mirror the external impulses and even accelerate the disruptions. Transformation, then, refers to the emergence of new societal components and structures and the radical reshuffling of existing structures and components. Therefore, crisis and transformation occurs relatively rarely and is a process of significant magnitude. Examples include radical change of societal practices due to emerging technology solutions with unexpectedly broad impacts; for example, one could imagine an explicit breakthrough in artificial intelligence, radical innovation that makes quantum computing widely available in society or a multifaceted negative event with widespread societal impacts, such as a war or a highly infectious and lethal pandemic.

#### 4. Concluding remarks

In the paper, I formulated a future-oriented dialectical approach based on an analysis of dialectical positions and dialectical processes, which were then divided into trajectory- and system-level dynamics. This approach is based on a seemingly simple starting point in which societal development is understood as the simultaneous opening of at least two parallel development pathways: the basic pathway and its opposite. Methodologically, this relatively simple “decentralisation” of the analytical perspective is useful in deconstructing the various linear and consensual assumptions of many futures research methods. In the paper, I argued that a dialectical approach helps in formulating a more grounded perspective on, for example, how new technologies embed in the societal sphere and the kinds of potentially complex repercussions of these technologies.

My approach is particularly apt for studying socio-technical changes, that is, changes that proceed through an interaction between multiple social and technological elements and related trajectories. In these processes, technological development trajectories and societal structures interact in surprising ways and form novel tensions and contradictions. The approach enables a systemic analysis of how future imaginaries impact societal settings as well as an analysis of technology-mediated practices in society. Technology-mediated practices condition many societal activities – our ability to participate, anticipate and contemplate – in today’s society, and this tendency is accelerating.

However, I also emphasised that I was only able to present a coarse outline of future-oriented dialectics. Plenty of questions still remain inexplicable. The first future task would be to further delineate the relationships between the dialectical positions, trajectories and system-level configurations. In this brief paper, it was not possible to fully elucidate how dialectical positions and processes are connected and interlaced, or what are their causal relations in different contexts. This elucidation requires further theoretical contemplation and empirical analysis.

The second future task is simultaneously conceptual, theoretical and empirical. There is a need to further clarify the concepts

utilised in the paper. For example, the specificities of dialectical positions, such as tension, contradiction, antagonism, conflict and parallax, require more explication and contextualisation. Only through further theoretical elaboration and empirical analysis will it be possible to discern the precise manifestations and meanings of specific positional concepts. The same goes for dialectical processes: The specific details of trajectory dynamics, such as parallels, crossings and bifurcations, can only be revealed through particular empirical analysis.

The third future task is methodological in nature: Future-oriented dialectics need to be compared in a more in-depth manner with various “neighbouring” methodological frameworks. Such frameworks include complexity studies, especially the framework of complex adaptive systems; systems analysis, especially more integrative frameworks, such as soft systems methodology, and methodologies in the social studies of science and technology, such as socio-technical transitions, including multi-level perspectives and large technical systems. Obviously, this methodological reflection should also focus on futures research methods (e.g. scenario analysis and other methods that build on futures images and imaginaries) and future-oriented frameworks in more established fields of social sciences, such as sociology of expectations.

The fourth future task is empirical in nature. As detailed above, there is a need for further theoretical work and for empirical case studies. This is required both for explicating more precise meanings of positional concepts and for making the use of various trajectory- and system-level concepts more incisive. Case studies could also build a robust baseline underlining the specific perspectives of dialectics. This would also emphasise the case that future-oriented dialectics is a contextual form of analysis that unravels most vividly in particular settings.

The fifth future task is related to the philosophy and theoretical basis of futures research. I argue that these kinds of exercises are worthwhile because they bolster the theoretical baseline of futures research and enable prolific scientific encounters with other fields of research – encounters which explicitly demonstrate the distinctiveness of the futures perspective. This kind of contemplation would also enable a critical questioning of the philosophical practices and selections of futures research, such as the following: What are the specific qualities that make societal trajectories future-oriented? What are the particular causalities between these trajectories? What do we actually do, and in what kinds of settings and contexts do we operate when we analyse future trajectories and events? How do we operationalise the past, present and future in these inquiries? In essence, the dialectical approach exhibits potential in illuminating the philosophical underpinnings of futures research.

## Funding

The research was supported with the funding of the Committee for the Future, the Parliament of Finland (project number: 1100M-28; journal number: 56/249/2017).

## References

- Ahlqvist, T., & Rhisiart, M. (2015). Emerging pathways for critical futures research: Changing contexts and impacts of social theory. *Futures*, 71, 91–104.
- Ahlqvist, T., & Sirviö, H. (2019). Contradictions of spatial governance: Bioeconomy and the management of state space in Finland. *Antipode*, 51(2), 395–418.
- Althusser, L. (1967). Contradiction and overdetermination. *New Left Review*, 1/41, 15–35.
- Andrianantoandro, E., Basu, S., Karig, D. K., & Weiss, R. (2006). Synthetic biology: New engineering rules for an emerging discipline. *Molecular Systems Biology*, 2(1), 1–14.
- Bachelard, G. (2000). *The dialectic of duration*. Clinamen Press.
- Balmer, A., & Martin, P. (2008). *Synthetic biology. Social and ethical challenges. An independent review commissioned by the Biotechnology and Biological Sciences Research Council (BBSRC)*. Institute for Science and Society, University of Nottingham. <https://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.362.8406>.
- Beckert, J. (2016). *Imagined futures. Fictional expectations and capitalist dynamics*. Harvard University Press.
- Benson, J. K. (1977). Organization: A dialectical view. *Administrative Science Quarterly*, 22, 1–21.
- Bloch, E. (1986). *The principle of hope*. Blackwell (Three volumes).
- Boudry, M., & Pigliucci, M. (2013). The mismeasure of machine: Synthetic biology and the trouble with engineering metaphors. *Studies in History and Philosophy of Biological and Biomedical Sciences*, 44, 660–668.
- Castán Broto, V. (2015). Contradiction, intervention, and urban low carbon transitions. *Environment and Planning D: Society and Space*, 33(3), 460–476.
- Castellacci, F. (2008). Technological paradigms, regimes and trajectories: Manufacturing and service industries in a new taxonomy of sectoral patterns of innovation. *Research Policy*, 37, 978–994.
- Chorev, N., & Babb, S. (2009). The crisis of neoliberalism and the future of international institutions: A comparison of the IMF and the WTO. *Theory & Society*, 38, 459–484.
- Christensen, C. M., McDonald, R., Altman, E. J., & Palmer, J. E. (2018). Disruptive innovation: An intellectual history and directions for future research. *Journal of Management Studies*, 55(7), 1043–1078.
- Crescenzi, R., & Iammarino, S. (2017). Global investments and regional development trajectories: The missing links. *Regional Studies*, 51(1), 97–115.
- Cserer, A., & Seiringer, A. (2009). Pictures of synthetic biology. *Systems and Synthetic Biology*, 3(1–4), 27–35.
- Derbyshire, J. (2016). The implications, challenges and benefits of a complexity-orientated futures studies. *Futures*, 77, 45–55.
- Dolan, T. E. (2018). Framing indeterminacy: Dialectical analysis and futures studies. *World Futures Review*, 10(1), 83–94.
- Dosi, G. (1982). Technological paradigms and technological trajectories. A suggested interpretation of the determinants and directions of technological change. *Research Policy*, 11, 147–182.
- Doudna, J. A., & Charpentier, E. (2014). The new frontier of genome engineering with CRISPR-Cas9. *Science*, 346(6213), 1258096–1–1258096-9.
- Dufva, M., & Ahlqvist, T. (2015). Elements in the construction of future-orientation: A systems view of foresight. *Futures*, 73, 112–125.
- Dunford, M., & Smith, A. (2000). Catching up or falling behind? Economic performance and regional trajectories in the “New Europe”. *Economic Geography*, 76(2), 169–195.
- Erickson, B., Singh, R., & Winters, P. (2011). Synthetic biology: Regulating industry uses of new biotechnologies. *Science*, 333, 1254–1256. <https://doi.org/10.1126/science.1211066>
- Ettlinger, N. (1999). Local trajectories in the global economy. *Progress in Human Geography*, 23(3), 335–357.
- Funtowicz, S., & Ravetz, J. R. (1994). Emergent complex systems. *Futures*, 26(6), 568–582.
- Geels, F. W. (2007). Transformations of large technical systems: A multilevel analysis of the Dutch highway system (1950–2000). *Science, Technology, & Human Values*, 32(2), 123–149.

- Geels, F. W. (2012). Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. *Research Policy*, 39, 495–510.
- Green, M., & Zierhofer, W. (2003). The unity of difference: A critical appraisal of Niklas Luhmann's theory of social systems in the context of corporeality and spatiality. *Environment and Planning A*, 35, 615–630.
- Halvorsen, S. (2017). Spatial dialectics and the geography of social movements: The case of Occupy London. *Transactions of the Institute of British Geographers*, 42, 445–457.
- Harvey, D. (1982). *The limits to capital*. Blackwell.
- Harvey, D. (2014). *Seventeen contradictions and the end of capitalism*. Oxford University Press.
- Hegel, G. (1977). *Phenomenology of spirit*. Oxford University Press.
- Jameson, F. (2010). *Valences of the dialectic*. Verso.
- Jessop, B. (2015). Crises, crisis-management and state restructuring: What future for the state? *Policy & Politics*, 43(4), 475–492.
- Kastenhofer, K. (2013). Synthetic biology as understanding, control, construction, and creation? Techno-epistemic and socio-political implications of different stances in talking and doing technoscience. *Futures*, 48, 13–22. <https://doi.org/10.1016/j.futures.2013.02.001>
- Laclau, E. (2006). Ideology and post-Marxism. *Journal of Political Ideologies*, 11(2), 103–114.
- Larner, W. (2011). C-change? Geographies of crisis. *Dialogues in Human Geography*, 1(3), 319–335.
- Lefebvre, H. (1991). *The production of space*. Blackwell Publishing.
- Lefebvre, H. (2008). Critique of everyday life. In *Foundations for a sociology of the everyday* (Vol. 2). Verso.
- Lefebvre, H. (2009). *Dialectical materialism*. University of Minnesota Press.
- Luhmann, N. (1977). Differentiation of society. *The Canadian Journal of Sociology*, 2(1), 29–53.
- Luhmann, N. (1990). Technology, environment and social risk: A systems perspective. *Industrial Crisis Quarterly*, 4, 223–231.
- Luhmann, N. (2006). System as difference. *Organization*, 13(1), 37–57.
- Luukkainen, J. (2017). System models in research and planning – Building a new dialectic framework. In S. Heinonen, O. Kuusi, & H. Salminen (Eds.), *How do we explore our futures? Methods of futures research* (pp. 54–63). Finnish Society for Futures Studies.
- Malabou, C. (2000). The future of Hegel: Plasticity, temporality, dialectic. *Hypania*, 15(4), 196–220.
- Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research Policy*, 41, 955–967.
- Marx, K. (1976). *Capital: A critique of political economy* (Vol. 1). Penguin Books.
- Massey, D. (2007). In what sense a regional problem? (Volume 13, Number 2, 1978). *Regional Studies*, 41(1), 49–59. <https://doi.org/10.1080/00343400701232181>
- Meillassoux, Q. (2011). Potentiality and virtuality. In L. Bryant, N. Srnicek, & G. Harman (Eds.), *The speculative turn: Continental materialism and realism* (pp. 224–236). re.press.
- Mouffe, C. (2005). *The return of the political*. Verso.
- Nomaler, Ö., & Verspagen, B. (2016). River deep, mountain high: Of long run knowledge trajectories within and between innovation clusters. *Journal of Economic Geography*, 16, 1259–1278.
- O'Brien, K.J. (2010, September 27). Nokia's new chief faces culture of complacency. The New York Times. Sept. 27, 2010, Section B, Page 1.
- Oye, K. A., Esvelt, K., Appleton, E., Catteruccia, F., Church, G., Kuiken, T., ... Collins, J. P. (2014). Regulating gene drives. Regulatory gaps must be filled before gene drives could be used in the wild. *Science*, 345(6197), 626–628.
- Peck, J. (2011). Geographies of policy: From transfer-diffusion to mobility-mutation. *Progress in Human Geography*, 35(6), 773–797.
- Rabinow, P., & Bennett, G. (2012). *Designing human practices: An experiment with synthetic biology*. The University of Chicago Press.
- Schmitt, C. (2007). *The concept of the political*. The University of Chicago Press.
- Secor, A. J. (2008). Žižek's dialectics of difference and the problem of space. *Environment and Planning A*, 40, 2623–2630.
- Sheppard, E. (2008). Geographic dialectics? *Environment and Planning A*, 40, 2603–2612.
- Skuras, D., Meccheri, N., Moreira, M. B., Rosell, J., & Stathopoulou, S. (2005). Business growth and development trajectories in lagging and remote areas of Southern Europe. *European Urban and Regional Studies*, 12(4), 335–351.
- Slaughter, R. A., Naismith, L., & Houghton, N. (2004). *The transformative cycle*. Swinburne: Australian Foresight Institute.
- Smith, A., Stirling, A., & Berkhout, F. (2005). The governance of sustainable socio-technical transitions. *Research Policy*, 34, 1491–1510.
- Smith, A., Voß, J.-P., & Grinc, J. (2012). Innovation studies and sustainability transitions: the allure of the multi-level perspective and its challenges. *Research Policy*, 39, 435–448.
- Soja, E. (1980). The socio-spatial dialectic. *Annals of the Association of American Geographers*, 70(2), 207–225.
- Soja, E. (1996). *Thirdspace: Journeys to Los Angeles and other real-and-imagined places*. Blackwell.
- Stahel, A. W. (1999). Time contradictions of capitalism. *Capitalism Nature Socialism*, 10(1), 101–132.
- Thomassen, L. (2005). Antagonism, hegemony and ideology after heterogeneity. *Journal of Political Ideologies*, 10(3), 289–309.
- Urry, J. (2005). The complexity turn. *Theory, Culture & Society*, 22(5), 1–14.
- Viskovatoff, A. (1999). Foundations of Niklas Luhmann's theory of social systems. *Philosophy of the Social Sciences*, 29(4), 481–516.
- Žižek, S. (2006). *The parallax view*. MIT Press.

**Toni Ahlqvist** is Professor of Futures Research at the Finland Futures Research Centre, University of Turku. He is an Adjunct Professor of Economic Geography and Technological Transformations at the University of Turku. Prof. Ahlqvist's research focuses on regional planning and policy, spatial political economy, futures studies, and technology foresight. He has lead numerous research projects that have covered, e.g., emerging technologies, construction and uses of futures knowledge in organizations and regions, strategic development of industrial branches, such as forest industry in South Australia, and varied aspects of knowledge-based society. His most recent projects have dealt with potential societal antagonisms of radical emerging technologies and future generations in the context of law-making. His research has been published in such journals as *Futures*, *Technological Forecasting and Social Change*, *Antipode*, *Foresight*, *International Journal of Urban and Regional Research*, *New Political Economy*, *Geopolitics*, *Geografiska Annaler A: Human Geography, Space and Polity*, *Technology Analysis and Strategic Management* and *Science and Public Policy*.