Recognizing that the map is not the territory enables practitioners to go beyond institutionalized descriptions of their systems to obtain a dynamically contextual understanding of the problems they handle. Reality is simplified when it is seen as equivalent to its representations. By contrast, it is complexified when, as well as representations, practitioners rely on their personal knowledge, developed from a historically informed, relationally constituted, bodily felt and situationally-based reading of the situation they are immersed in.

Tsoukas and Dooley in ‘Towards the ecological style: Embracing complexity in organizational research’ (2011, p. 731-2)
Breakdowns and disruptions render certain unwanted images of a world where events are unknowable or indeterminate: we do not know when or where the next breakdown will occur, and neither can we determine beforehand what its impact will be and whether it will be the start of a cascade of unfortunate events spreading through our networked society. Such ideas violate and stand in stark opposition to several central ontological presuppositions of what has been called the condition of ‘modernity’. We live in an epoch where we believe reality to be controllable, inspectable, causal, and knowable (see for example Edwards, 2003; Foucault, 1970; Kallinikos, 2005; Law, 1994; Toulmin, 1990; Townley, 2002; Tsoukas, 1997). A central argument in this dissertation has revolved around the idea that the management of breakdowns is to be understood in the context and discourse of ‘complexity’.

This is not just an arbitrary remark. Using the adjective ‘complex’ to describe our systems and its breakdowns is not merely using the word in a descriptive sense but also, as Tsoukas and Hatch (2001, p. 989) claim, using this as a specific vocabulary ‘because of its suspected utility – it may enable you to do certain things with it’. Rather than an unexpected event that took us by surprise, an understanding of complex breakdowns promises that we can unravel and reduce its complexity, learn from it, change our systems and prevent future breakdowns. In other words, describing breakdowns and systems as complex illustrates our desires to make these breakdowns and systems more knowable and determinate.

The purpose of this dissertation has not been to argue against the idea that we can or should learn from breakdowns, and neither that it would be undesirable to think about how we can change our systems to potentially prevent certain kinds of disasters. On the contrary! I have tried to argue that an understanding of infrastructure breakdowns through the aspiration of reducing its inherent complexity may very well undermine the nature of breakdowns, thereby only providing an illusion of control.

To resolve this issue of complexity I have argued to take into deeper consideration how organizational actors cope with the complexity they encounter in infrastructure breakdowns. To do so, I suggested blurring the binary distinction that is often made between an infrastructure that is at one point functioning and at another broken down. I have set out to develop an understanding of infrastructure as a recursive process: it is both an object structuring social life by allowing the flow of people and goods, while at the same time it is itself structured by that social life, for example through how infrastructure is organized and how its breakdowns are dealt with. From such a perspective, the notion of breakdown changes. Rather than focusing on breakdowns as ‘dramatic disasters’ that are a serious break
with the orderly flow of events, I suggested to, instead, take seriously the role of breakdowns as ‘daily disruptions’ to focus on how actors deal with breakdowns.

Such an alternative conceptualization has the potential to uncover the dynamics of how an infrastructure is in a continuous state of ‘becoming’: never finished once and for all, never totally gone, but always in this liminal state where infrastructure is simultaneously constructed as well as deconstructed, constructing as well as deconstructing. Moreover, thinking about infrastructure as a recursive process allows taking into deeper consideration how infrastructures and breakdowns are related: infrastructure emerges through breakdowns and how organizational actors cope with complexity in these breakdowns. In this dissertation I have studied this phenomenon in the context of work and organization, claiming that infrastructures have to be made to function through the organization and ordering work of people and technologies, most specifically in their interaction as a sociotechnical whole. With the above in mind, I will now answer the research question that informed this dissertation: how do organizational actors cope with the complexity of breakdowns and how does this shape the functioning of the railway infrastructure?

8.1 From distinctions towards relations

The empirical chapters have illustrated that coping with complexity in infrastructure breakdowns always, to some extent, happens on the basis of representations; the functioning of the infrastructure is contingent upon how people exactly use these representations in dealing with the breakdown. To make this idea more concrete, I have at various points suggested using a thinking tool to make sense of how complexity in breakdowns are dealt with in the Dutch railway infrastructure. The idea that ‘the map is not the territory it represents’ sensitizes us to understand the different ways that reality can ‘come to us’. We experience the flux and flow of reality phenomenologically from within the territory while we make sense of this reality through maps that claim to represent that territory. This observation is so informative in the context of organization and work, because organizing in essence is a form of map-making: ‘representing work is the stuff of which organizations are made’ (Suchman, 1995, p. 61). We thus go and manage the organizational complexity through maps that claim to represent reality in order to reduce, make sense of, and organize the complexity, while at the same time we have to be aware of the fact that these maps are of quite a different
logical order than the territory they represent (see table 3 on page 56 where I explicated these logical types using a tentative list to describe some characteristics of the map and the territory).

The findings and conclusions of my empirical chapters show that analytical distinctions between maps and territories may make sense in theory but turn up as more problematic in practice. For Law and Mol (2002), complexity means that something is more than one but less than many; it is more than one monolithic order without directly falling into a state of chaos. Thus, so they argue, to understand complexity means to understand how these different orders are related and ‘hang together’ (see also Mol, 2002). In a sense, the map and territory, although in many aspects crucially different, also ‘hang together’ in practice. One could indeed wonder whether it is possible at all to have access to ‘raw’ reality. The world we see and experience is always and already interpreted by numerous bodily, affective, and cognitive filters or maps. The banana I look at is not yellow by itself, but I see it as yellow because my retina has certain cells that can make distinctions between different objects that absorb and reflect light in different ways; how we perceive the world and make decisions is always already ‘colored’ by our moods and affect (Heidegger, 1926/1996; Zundel, 2012); language is this ‘tyranny’ (Chase, 1938) that is necessary for us to make sense of situations while words are always abstractions of a specific context.

Thus, stopping the argument here – now we have a better understanding of how the map and the territory are different – would only allow for a trivial conclusion. The mere attempt to describe ‘reality’ by referring to a territory is incomplete, as it denies the fact that this name-giving is already an interpretation of ‘that-something-that-has-no-name’ and, moreover, because it suggests that maps would belong to a distinct realm of ‘non-reality’.

As Tsoukas (2016) has argued in a recent article, we need complex theories if we want to understand complex organizational phenomena (see also Heylighen, Cilliers and Gershenson, 2007; Morin, 2005). Complex theories, as I understand it, can be informed by some of the practice-theories that have inspired this book. It is an attempt to bridge the practice/theory divide to find if and how theory can be more than an abstract explanation of practices that renders events lifeless (e.g. by cutting it up in ‘independent’ variables). Are there, for instance, also ways of theorizing that do not succumb to this ‘failure’ and can, perhaps, theorizing itself be seen as an example of engaged practice (Zundel and Kokkalis, 2010)? Rather than separating concepts into different variables, then, a complex theory should be conjunctive. It should seek for connections between concepts or variables (e.g.
the map and the territory) to provide thicker descriptions and understandings of human experience (Tsoukas, 2016, p. 17). Below I will further develop the thinking tool that has been central to this dissertation, by attempting to understand how the map and the territory relate rather than how they are divided. Based on the empirical chapters, I sketch out three different scenarios that highlight how organizational actors cope with complexity in infrastructure breakdowns by means of maps. These scenarios should be interpreted as ‘ideal-types’; they do not exactly describe a reality but are a frame through which to analytically understand a phenomenon. In practice, and the empirical chapters have illustrated this, none of these scenarios exist in such a pure form. I have summarized the scenarios in table 8 on page 194, which should be used as a reference while reading the following pages and in understanding the overlap and differences between the scenarios.

8.1.1 Scenario 1: Maps as heuristics

The first map-territory relation is one that highlights our often deeply practical engagement with the world. While immersed in practical action (ranging from walking and hammering to writing a dissertation and train dispatching) we do not encounter maps that are distinct from our practice, but we find guidance in and pragmatically use those maps within our practice. In several of the chapters this relation has been prominent. In chapter 3, for example, we see how train dispatchers deal with breakdowns by means of knowledge learned both through maps (e.g. formal educational models, handbooks) and from within the territory (e.g. bodily and sensible knowledge). Dispatchers come to understand breakdowns through the practices of knowing, reading, and imagining their equipment, and this addresses the fact that maps – even when ‘stored’ as cognitive or mental maps – are always used in the here and now and with a practical goal in mind. Knowledge about maps and the territory that is grounded in dispatcher’s experience helps them to attune to emerging and practical situations and perturbations. In chapter 7 we see the map in the form of code T.I.S. 3.1: ‘a collision with person, bike, moped, or other small object’. Although I have been rather critical about the consequences of increasingly objectifying the dead body into the abstract code – and I maintain, this must raise at least some ethical questions – we can also interpret the code as an example of a bureaucratically installed heuristic: the code rationalizes a horrific event to such an extent that the situation may become workable. Rather than being paralyzed by the complexity of the dramatic and dirty context of the railroad suicide, the code triggers a network of railway employees by offering practical goals to immerse in.
However, although maps are a guidance for practical action, maps can become contestable. Take chapter 4, where railway coordinators make sense of a potential winter storm by using certain tools that are offered by the organization, such as the weather matrix or decision-tree. The maps here fail to provide the clear-cut answers that they promise. We then see how coordinators decide to deny how the maps guide their sensemaking. We can interpret this in two ways: i) the maps themselves are ambiguous – or, rather, they represent the territory in an ambiguous way – and, therefore, they fail to accommodate the professional judgment of the coordinators, eventually leading to a non-decision; or ii), the maps are not ambiguous at all, but they are interpreted ambiguously in order to accommodate the professional judgment and practical orientation of coordinators. It may indeed be a notable example of how we deal with the indeterminate nature of breakdowns: we see coordinators putting an end to certain maps that are not of use at that time and for their practical interest. Maps, by nature, are of an abstract and general quality, thereby excluding temporality. Maps try to close, whereas the territory requires openness. Thus, when we see maps as a heuristic that can support us in our practices, we may also conclude that at times they are not available to us to use in that specific and practical situation.

As we cannot always predict events in the territory, we need maps that support us in our sensemaking to make the right decision but also maps that appreciate the open-endedness of the world. It reminds of a story as told by Weick (1995) in his seminal work on sensemaking in organizations, where he describes how organizational actors, when confronted with a confusing world, cognitively map the equivocal input of their environment into a more orderly whole. He refers to Miroslav Holub’s (1977) poem ‘Brief Thoughts on Maps’ to tell the story about a detachment of Hungarian soldiers lost in the Alps. One of the soldiers finds a map in his pocket that leads them back to their camp. Once back, however, they discover that the map is not of the Alps but of the Pyrenees instead. Weick thus sees maps as a heuristic and concludes that they can function as a pragmatic tool to navigate and charter unknown territory, saying that ‘when you are lost, any old map will do’ (Weick, 1995, p. 54). Such maps can thus support our sensemaking in order to make the right decision at the right time, and the exact details of the decision are contingent upon the practical demands of that moment. In chapter 6, for instance, we have seen how the architectural map of the OCCR at times were found constraining for practical action, whereas at other times – i.e. when actors were able to use maps flexibly – the architecture supported action and actors were able to better deal with specific situational demands (e.g. the ‘car hood’).
Maps as heuristics can best be interpreted as tools that actors use in a practical sense. From within the territory we phenomenologically encounter the flow and flux of life while being practically engaged in our projects. It is, what Heidegger (1926/1996) refers to as being-in-the-world, the essence of how humans are in the world before we start theorizing or reflecting about that world. The train dispatchers in chapter 3 deal with breakdowns without having to think about how to deal with breakdowns. Or, to be more precise, while absorbed in their work, they do ‘think’ about their practice but in a non-cognitive way. Breakdowns may very well be repaired in non-reflective and absorbed ways, and it is not until the dispatching practice comes to a full stop (e.g. the computer systems shut down) that people resort to more deliberate and cognitive repair work (Yanow and Tsoukas, 2009).

This suggests that – often – maps are not separate from the territory, as we may already use maps in non-reflective ways. Maps are used, developed, and adjusted in practices and this happens based on experience as much as theoretical knowledge. Hutchin (1995) and Suchman (1995, 2007), for instance, challenge the idea that maps are only ‘mentally’ available by introducing cognition as sociocultural and situated, something they call respectively ‘cognition in the wild’ and ‘situated action’. Hutchin analyzes navigational practices as both happening on a computational level and on a level of wayfinding, meaning how people “‘feel their way’ through a world that is itself in motion, continually coming into being through the combined action of human and non-human agencies’ (Ingold, 2000, p. 155, emphasis in original). Suchman (2007) aims to blur the boundaries between plans and situations, arguing that plans are not merely mental representations of a world but that ‘planning’ (or ‘mapping’) already happens in concrete and material circumstances. Moreover, she advises that representations of work can only serve as a useful tool for organizational members as long as they are embedded in the lived experience of those workers; problems may arise when normative representations of how work should be done are used in place of the practical knowledge of workers (Suchman, 1995, p. 61).

8.1.2 Scenario 2: Maps as (inaccurate) representations

The second scenario shows how coping with complexity through ‘neutral’ representations is not a neutral endeavor at all; attempts to reduce complexity, from this perspective, in fact create new dynamics, thereby producing another layer or level of organizational complexity. In chapter 5 I have analyzed the role of a performance indicator on the work of coordinators.
The indicator can be interpreted as a map meant to bring the organizations closer to ‘reality’. In the territory of the railways things happen that are perceived as undesirable and that are not always controllable such as, in the case of chapter 5, an unpunctual train service. The indicator in a sense aims to control the indeterminateness of the territory by measuring and thereby ‘mapping’ certain causal relations. The change in the color of the indicator on the video walls supposedly reflects the punctuality of trains, but it also indirectly measures the work of coordinators: a change in the color of the indicator says something about their performance, and it should also remind them that they are the ones who can make the service punctual again.

In this second scenario of how maps and territories relate I stay closest to Korzybski’s (1933) idea that the two are not one and the same but that they are related on the premise that we need the map to understand the territory. It is this scenario that most clearly presents an epistemological impasse: if we only have access to our world through maps, and if maps are always incomplete and simplified representations of that world, then how can we know anything about this world? At the roots of this problem are at least two oppositional moves: a desire to get closer to the world through maps and a realization that maps are simultaneously distinct from that very same world. We experience the world by making abstractions of that world, and these abstractions are always and necessarily so incomplete (Bateson, 1987; Cooper, 1986; Hernes, 2014). We map things by giving them names, signs or symbols, but the words should not be mistaken for the things they represent as ‘the name is not the thing’ (Chase, 1938, p. 25 emphasis in original) or, as a more concrete example, ‘the word “cat” cannot scratch us’ (Bateson, 1987, p. 186). This name-giving is a form of abstraction: the selection of certain aspect or properties and the elimination of others to make sense of the flux of experience. Such a categorization works on the premise of negation. For example, we map all the individual trees (tree₁, tree₂,…treeₙ) in the category ‘tree’ and all non-trees in the category ‘not tree’ and, similarly, we categorize ‘complexity’ and ‘not complexity’. Organizing works in a very same way: ‘it is the process of subsuming particulars under generic categories’ (Tsoukas and Chia, 2002, p. 573).

Going back to the findings of chapter 5, the problem is not so much the indicator itself that is mapped onto the world, but it is this abstract and generalizing quality of the indicator that leads to certain knowledge gaps: there is a mismatch between the particular circumstances of the train service at a certain point in time and the general information that the indicator generates. We seem to forget that the indicator is nothing more or less than a
measurement apparatus, thereby not providing unmediated access to the world but a specific frame to interpret this world. It thus tries to get closer to the ‘complexity’ of the territory but it can only do so by cutting the territory up in separate and causally related aspects, thereby actually undermining what it wants to know. As became clear in the data, punctuality is only one way of how we can look at the railway world, and a punctual train service is certainly not always a good one. More importantly, still, the map in this case had consequences in the territory, some of which were perceived as undesirable. The generalizing duality of the indicator, meant to reduce complexity in coordination practices, was badly capable to support the practical demands of coordinates; the employees’ attempts to resist and work around the indicator should thus be interpreted as the production rather than reduction of organizational complexity.

From the perspective of this scenario such knowledge gaps are unavoidable. The categorization of ‘things’ from the territory onto a map is not necessarily undesirable, as it fundamentally is the way through which we experience the world. However, this scenario also warns we should be wary for reifications, where the word is confused for the thing, or the map for the territory. This is what Whitehead (1926/2011) calls ‘the fallacy of misplaced concreteness’: we reify open-ended processes by giving it the appearance of being situated in a concrete and contained space and time. We can see this fallacy in the data of chapter 5, and similarly, chapter 6 illustrates this fallacy when open-ended processes of ‘inter-organizational collaboration’ are subsumed under the general category of spatial change. The general understanding of collaboration does not meet the particularities of it in practice.

It should be noted that in both chapter 5 and 6 we have also seen how coordinators resisted those maps that had become too ‘fixed’. Through ‘hiding practices’ and ‘territorial practices’ coordinators found ways to work around and circumvent the abstract maps. This should not be interpreted too easily as the popular idea that humans generally tend to avoid or resist changing circumstances. How I see it, the practices of coordinators were not so much a reaction against the maps, but they were produced by those maps. Zundel (2014) reminds us that what appears on the map is of a different logical type than what it intends to represent. Complexity, then, is not so much an inherent property of living things but mostly reveals the logic of us dividing this world into the categories of ‘complexity’ and ‘not complexity’. Coping with complexity, then, becomes a matter of what we define as a preferred orderly state; it concerns making visible and sayable (in words, models, measurement systems, etc.) a world that is to a large extent unsayable, invisible, and inaccessible to us. In an ironic sense, maps
such as the indicator or spatial change promise to reduce the complexity of the territory but, in doing so, they force the fluid territory into a fixed and stable order, thereby actually producing a more complex situation.

The main difference between the first and the second scenario can be found in what is taken as the starting point of coping with complexity. Whereas scenario one starts from within the territory from where practical demands urge actors to use or not use maps, this logic becomes inversed in the second scenario. Here, in first instance, the maps are leading as they normatively represent how specific situations ‘should be’. In practice, however, this representation is always incomplete, and ways should be found to fix this, thereby triggering further dynamic responses. What this scenario tells us is that maps require a kind of reflexivity. Maps are necessary for us to have access to the world but, at the same time, they are always incomplete and inaccurate. It would be naïve, for instance, to conclude that the organized spatial change discussed in chapter 6 could happen without architectural plans. Of course, we need maps to work towards practical solutions, but managers should know these maps are means to establish a new organizational reality rather than ends in themselves. Such reflexivity especially makes an appeal on how we deal with the paradoxical nature of (organizational) life: how do we deal with indeterminateness without falling into a state of chaos; how do we deal with trade-offs between standardization and flexibility, or stability and change; how do we get to know a world that is unknowable? Reflecting on such paradoxes, moreover, should not be meant as a way to resolve them or to choose and prefer one side of the paradox; reflection should help to strike a delicate balance between the two sides of a paradox, as they are essentially unresolvable (Lewis, 2000).

8.1.3 Scenario 3: Maps, maps, maps...

The last scenario on the map and territory relationship is perhaps one with a slightly negative undertone. Here, the relationship between the two is absent, not because they are so greatly separated but because there is no distinction to be made anymore. Or, to put it more precisely, the maps have taken over the territory to such an extent that one can hardly speak of a territory anymore. When maps lose their resemblance to a territory, it now is the map that has become the ‘problem’ to be managed. Whereas scenario 2 appealed to questions of epistemology, this scenario invokes questions challenging some of the ontological assumption in relation to the reality status of maps and territories. In this scenario, the maps have gone
wild. Like those, arguably, postmodern movies such as ‘Donnie Darko’ and ‘Eternal Sunshine of the Spotless Mind’, the boundaries between what is real and what is imagined or virtual are gone. Although difficult to grasp, I will show how this scenario helps to interpret some of the empirical examples in this book.

Instead of handling delayed and upset passengers in an actual train, we now have a performance indicator that we should keep happy (chapter 5); instead of the threat of extreme weather we now have a weather matrix that guides our decisions, and we are surprised and astonished when the weather does not act as the matrix had predicted (chapter 4); instead of a physical building with tangible people we now have a designed space mapped on architectural plans that prescribes and structures how we should behave (chapter 6); instead of blood-covered trains and a fragmented body corpse, we now have a system that tells us this ‘disruption’ should be managed within 130 minutes; when this does not correspond to the actual situation we are surprised that the actual situation does not correspond to what our systems say – e.g. that the dead body has refused to leave the tracks within the set time frame – instead of the other way around (chapter 7).

We can understand this better through what Foucault (1970) has problematized as the relation between the word and the thing. Words in the Renaissance epoch, according to Foucault, operated by means of resemblance. Words resembled – were signs of – the things in the world and, as such, our ideas and (theoretical) imaginations united the words and the things. In the Classical era, however, words came to represent the things, thereby separating rather than uniting the things in the world into distinctive and independent elements. Language became a way to neutrally represent the world (this is this, and this is not that) and this increasingly allowed a classification of things. It is in the current Modern epoch, the one Foucault scrutinizes in his book, that words and things are even further disconnected: they do not longer operate by means of resemblance and neither do they merely represent the world, but ‘[w]ords have swallowed up their own nature as signs’ (Foucault, 1970, p. 54). Words no longer relate to the things in the world, but they only relate to themselves and to other words. Not unlike the Droste effect or some works of Escher where images are constantly repeated in the image, this creates a system where meaning is only meaningful in reference to itself. In other words, maps used to cope with complexity have lost the ability to say anything meaningful about the territory.

For Baudrillard (1994, p. 1), this means we live in a world of simulation: ‘today it is the territory whose shreds slowly rot across the extent of the map’. It is, in late modernity,
that we seem to live in maps and maps only; the maps themselves have become some sort of substitute or *simulacrum* (Baudrillard, 1994) to the concrete world they once resembled. Things do not longer have any original and the maps we live by do no longer refer to any territory; in fact, maps actually feel more real than the real, and have become a hyper-reality. For Tsoukas (1997) this might be a result of the incremental reduction of knowledge about the world into knowledge as information. Nowadays, we understand the world through knowledge that is objectified, abstract and decontextualized information (see, for example, the knowledge that is ‘generated’ through the performance indicator in chapter 5). This type of knowledge promises a transparent world (Tsoukas, 1997) and is effectively employed by organizations through, for example, performance measurement systems (Townley, 2002; Townley et al., 2003). Ironically, it are exactly these same characteristics of modernity that also foster the darker sides of a presumed ideology of visibility and accountability (Zyglidopoulos and Fleming, 2011), as it concerns not only the politics of what is put forward as information but also what part of the story remains untold. In other words, maps have a performative effect in the sense that they guide what becomes visible and what invisible, what is sayable and what remains unsayable.

If we follow Baudrillard’s ideas to the extreme, we encounter some pretty terrifying consequences of maps and map-making. Instead of living in a world that we perceive as complex and where things sometimes ‘talk back’ in unexpected ways, we now have a map of that world talking back. We have created simulations as a substitute to the real to such an extent that we live by these simulations only, and this copy world now is a representation without an original referent. Instead of maps that, inaccurately perhaps, try and understand a complex world, we now need someone (who?) or something (what?) that tries to tame these maps which were supposed to tame our very own world in the first place! In this view, we are left with mere substitutions of a phenomenologically experienced world, and coping with complexity means to cope with those simulations, created by ourselves, of the world.

As already stated, the three scenarios should be seen as ideal-types, and in practice the different coping mechanisms were able to ‘neutralize’ each other’s unwanted side-effects. Nonetheless, what this scenario shows is the potential power of maps and, more importantly, the power of believing in and managing through maps. If maps can indeed be equated with what it means to organize, we should tread their uses lightly.
8.1.4 Wrapping it up: from infrastructure towards infrastructures

From the above discussion it appears that we cannot answer the research question in one clear-cut way. How the organizational actors in the Dutch railway system cope with complexity in breakdowns and how these coping strategies shape the functioning of the infrastructure is to a certain extent contingent upon how complexity is perceived: different perceptions of complexity give different kinds of agency to maps. On one end of the continuum, maps are mere tools to engage with breakdowns in a practical sense and infrastructure comes about through the practical demands of specific situations. In the middle we see how people use maps that are inaccurate or incomplete, and the functioning of infrastructure relates to how these mismatches are managed in practice. On the far other end of the continuum, maps have taken over the railway territory, and we can wonder whether coping with complexity has in fact not become synonymous with coping with maps. In this case, how infrastructure becomes is best defined as a process increasingly trying to solidify not what an infrastructure is but how it should be according to its representations.

Scenario 1 perhaps seems most fragile to unexpected circumstances. However, it is also its openness and fragility that gives the infrastructure its strength. It takes stability not as the starting point of how the infrastructure should be, but infrastructure is in a sense temporarily stabilized through the continuous efforts to deal with changing demands. In scenario 2 we see how breakdowns in infrastructure are already filtered in more normative ways as they are embedded in the maps that are used to manage these breakdowns. While this may be powerful during reflective moments where maps and breakdowns are continuously being evaluated in the context of specific situations (does this work for now?), it could potentially also lead to epistemological paralysis: nothing works for now as nothing precisely reflects the situation. In scenario 3, the infrastructure is to a large extent fixed, and stability is the norm. This is possible because we have reduced the infrastructure to its representations. This scenario has an appearance of control: there are no more unexpected events to imagine because our maps have already excluded them as possibilities – we have made them part of a calculative ratio between what we find ‘orderly’ and ‘disorderly’. As this scenario works on the premise of a simulated infrastructure, it indeed becomes possible to think everything through and to exclude the unexpected.

However, underneath the simulated maps the territory still brews its plots and life unfolds as life unfolds, and when the strictly managed territory goes sideways we are suddenly in a world that does not behave as we expect it to. Thus, whereas the pompous scenario
3 screams: ‘Relax! Everything’s under control’, and the skeptic scenario 2 is still trying to find ways to control that recalcitrant territory better, the more humble scenario 1 whispers: ‘Relax, because nothing is under control’. The most surprising observation, here, is that the ‘input’ and ‘output’ of coping with complexity are to some extent inversely proportionally related: the more force we use to make the world behave according to our maps, the more resistance we may expect; the harder we squeeze our hand to hold the sand, the more the sand slips through our fingers. In the end, the railway infrastructure is both map and territory, and failing to see this multiple, layered, and – indeed – complex nature of infrastructure is what, ironically, turns up as complexity in practice.

There is thus a possibility for multiple infrastructures to exist simultaneously. Of course, for the innocent passenger there is only the train she is in. Infrastructure, in a sense, thus also functions precisely because it can hide the fact that there are different infrastructures in operation. Methodologically uncovering the world behind infrastructure in what Bowker (1994) has called ‘infrastructural inversion’, however, I have attempted to understand some of these different infrastructures of the Dutch railway system. The train driver in the train and the traffic coordinator at the OCCR may look at the same railway tracks, but they may see a very different infrastructure. I would argue that this is more than a matter of perspective only, and neither is infrastructure merely socially constructed. It is in practice that infrastructures – both as an object and as an idea – take on the appearance of and are encountered as a specific infrastructure at that moment in time. What ‘counts’ as infrastructure for the driver as well as for the coordinator (and, as a matter of fact, for all the people looking at the railways, professionally or as a passenger) depends on their practical engagements with it. It is not necessarily problematic that there exist different infrastructures at once; this is what makes the train go from A to B in the first place.

But are we able to accept such profusion of something that, in first instance, looks like nothing more than an uncontestable object? Bowker and Star suggest that our systems and infrastructures are inherently categorized and classified, and this has certain consequences in the context of which voices are heard and which ones are rendered silent (1999, p. 4-6). This undoubtedly reflects the political context in which the railway organizations operate, something on which this dissertation has been rather silent. Under the adagio of New Public Management, we may wonder whether the railways nowadays are managed by means of instrumentality or governed by means of goals and interests. I would say that the case of chapter 4 makes an argument for both sides, and it may exactly be this struggle between the
two sides that shapes how organizational actors cope with complexity in the infrastructure. On the one hand the organizations need to construct this image of them being in control, while on the other hand – and we all know this – they simply are not always and everywhere in control. It is this precarious nature of infrastructure as always somewhere on the verge of breaking down that shows that the railway organizations need to find the right balance between stability and movement; between determination and indeterminateness; between providing a safe train service and one that is safe enough but also takes into consideration the importance of the availability of the larger system.

In sum, in this dissertation I have sought to provide an alternative understanding of infrastructure breakdowns, arguing for dissolving the distinctions we usually draw between the infrastructure as functioning and the infrastructure as broken down. I have shown that a focus on the work, organization, and coping strategies that are involved in keeping an infrastructure ‘in place’ draws our attention to the dual and sometimes paradoxical nature of infrastructure as being both a stable object and an open-ended process, both visible and invisible, both functioning and breaking down. An infrastructure is thus always a matter of infrastructures; it are the different, sometimes opposing but always related structures that we ourselves have constructed underneath our feet, built above our heads, and implanted within those networks we use on a daily basis to cope with what life brings us. Infrastructure as a multiplicity may be complex, but it is also this multiplicity and complexity that is at the heart of what infrastructure is. Taking complexity seriously means to refuse to fantasize it away. Breakdowns will happen, and Monsters and Mess will be encountered on the railways. Stopping to see these Monsters as anomalies and Mess as an enemy to our orderly world and, on the contrary, starting to truly embrace them as an inherent part of our infrastructures is, possibly, a way forward in understanding the complex nature of infrastructure and its breakdowns.
### Table 8. Summary of the three map-territory scenarios

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<tr>
<td><strong>Where is complexity ‘located’?</strong></td>
<td>Complexity resides everywhere in the territory and is thus nowhere ‘located’ specifically; there is only open-endedness and indeterminacy; this is accepted and dealt with in practical ways; if there is something like complexity, it is not something to be resolved</td>
<td>The territory is perceived to be complex; this is only reflective of our knowledge gaps; it is in attempts to resolve these gaps to reduce perceived complexity that complexity is created; complexity is ‘located’ in mismatches between maps and the territory</td>
</tr>
<tr>
<td><strong>How are the map and the territory related?</strong></td>
<td>Maps are not merely representations of the territory but they are simultaneously part of the territory; they can be used pragmatically in order to deal with specific situations</td>
<td>Maps represent the territory; although they are always incomplete, they do provide a specific (though only partially accurate) frame to look at the world</td>
</tr>
<tr>
<td><strong>How do actors cope with complexity (in infrastructure breakdowns)?</strong></td>
<td>Most breakdowns are dealt with while absorbed in practice; they can be dealt with non-cognitively; maps can be of help, but they can also be discarded as not helpful for the practical demands at that time</td>
<td>Breakdowns are filtered by specific maps that act as a frame through which complexity is managed; according to the map, specific actions should logically follow specific breakdowns; according to the territory, some of the maps should be circumvented; coping with complexity happens somewhere in between the abstract and the concrete breakdown</td>
</tr>
<tr>
<td><strong>How ‘becomes’ the infrastructure?</strong></td>
<td>To a certain degree we cannot answer this question as infrastructure becomes as an open and indeterminate process; the outcome is guided by maps but eventually shaped by practical demands; infrastructure is always on the move and only temporarily stabilized in efforts to organize</td>
<td>It emerges from interconnections between the concrete and abstract infrastructure; maps subsume concrete situations into general categories to make infrastructure less complex; ironically, it is only the abstract infrastructure that becomes ‘less’ complex and it is in the concrete infrastructure that complexity is now produced</td>
</tr>
<tr>
<td><strong>Keywords/themes</strong></td>
<td>Professional judgment; expertise; practical coping; embodiment</td>
<td>Knowledge and epistemology; negation; categorization; reflection; paradoxes</td>
</tr>
</tbody>
</table>
8.2 Theoretical implications for the complex systems literature

The main contributions of this dissertation in the context of complex systems literature are the investigation in what it means for something to turn up as complex and the exploration of the value of ‘daily disruptions’ to better understand system breakdowns. Below I will first elaborate the former, and the latter will be taken up in the next section.

The concrete research aim of this dissertation was to develop an understanding of those practices through which organizational actors cope with complexity in infrastructure breakdowns. I have argued that to understand such practices one inevitably has to investigate how organizations and its actors conceive of the complexity of their infrastructures and breakdowns. This is especially relevant, as it has been noted that ‘management’ (seeking order and controlling disorder) is at odds with the constitution of ‘complexity’ (see for instance Chia, 1998; Cooper, 1986; Tsoukas and Hatch, 2001). As Yates (1993) showed in her historical analysis of the rise of system thinking in organizational life, it was at the Illinois Central Railroad – one of the first dispersed and decentralized networks – where the need for the simplification and control of complex systems first emerged.

It should be applauded that over the past decades the notion of complexity has increasingly inspired the natural as well as social sciences (Baranger, 2000; Prigogine, 1989). Complexity systems literature has established a specific discourse about systems in the attempt to break with the classical ‘Newtonian’ sciences which, by virtue of their emphasis on studying measurable and separated properties of certain phenomena in a controlled environment, are acontextual and ahistorical (Tsoukas and Hatch, 2001, p. 990). Drawing on complexity sciences and related concepts (e.g. emergence, recursiveness, non-linearity, sensitivity to initial conditions) our understanding of social systems has greatly advanced by finding ways to account for the uncertainty and indeterminateness of the world. Rather than fantasies of prediction and total control, complex systems literature shows that organizing involves diverse and open-ended ways of coping with complexity in practice.

However, a more critical understanding of this literature (e.g. Chia, 1998; Heylighen, Cilliers and Gershenson, 2007; McKelvey, 2001; Morin, 2005) also shows how studies on complex social systems that are informed by complexity science still operate from within a restricted paradigm. In order to understand and account for the open-endedness and indeterminateness of social systems through a complexity lens, these studies do so by means of closure and searching for general laws to reduce complexity (see for example the work of...
Anderson, 1999; Holland, 1995; Maguire et al. 2006; Morel and Ramanujam, 1999; Simon, 1962; Vidal, Marle and Bocqet, 2011; Waldrop, 1993). For instance, as Holland (in Waldrop, 1993, p. 107, emphasis in original) claims: ‘All complex, adaptive systems – economies, minds, organisms – build models that allow them to anticipate the world’. Thus, by unraveling the complexity of systems and uncovering their unique ‘models’ or inherent ‘characteristics’ it is promised that we can anticipate and perhaps even predict the indeterminateness of the world. Such reasoning, which is still reminiscent of reasoning according to propositional and causal statements, understands complexity by reducing complexity, as if one could understand fluidity and open-endedness by fixing it and giving it permanent form. The contribution of this dissertation is the critical examination and questioning of this fundamental ‘logic’ in the complex systems literature. Through the three scenarios, I have offered a deeper understanding of the different ways that people cope with complexity in practice. Complexity as an inherent quality rather than a hindrance, for instance, is something that may stimulate further debate.

Complexity is not only a feature of the systems we study but also reflects our ways of thinking about these systems (Casti, 1986; Tsoukas and Hatch, 2001). In other words, there is no observer-independent system out there that has the inherent quality of being complex, but it is through our language that we can begin to describe systems as complex. As Casti (1986, p. 151) has convincingly argued, a pen may be a rather simple object for someone writing a manuscript, as she has only one mode of interacting with the pen. For someone who has many non-equivalent modes of interacting with the pen (e.g. a chemical engineer who may look at the compound of the materials of the pen, the chemicals of the ink, etc.), the pen may become a complex object because the language used to describe the possibilities of the object have become larger. Thus, in order to understand complex phenomena in organizations one needs complex rather than reductionist ways of thinking (Chia, 1998; Tsoukas, 2017). In this dissertation I have done so by developing, amongst others, a processual understanding of infrastructures to account for how breakdowns as ‘daily disruptions’ are not exceptional to infrastructures. It is in this respect that this dissertation contributes to the literature on organization studies in general and the management of complex systems in particular.
8.2.1 The temporality of infrastructures and systems

As several of the chapters have shown, there resides a whole world of work between the infrastructure that functions and the infrastructure that is broken down. From a phenomenologically grounded perspective, breakdowns may change our mode of practical engagement with the world (Heidegger, 1926/1996). However, the large majority of breakdowns we encounter in our practices are being dealt with from within the practice, that is, non-reflective and through practical coping with specific situational demands. It is only when something appears to truly break down (the car refuses to start after several attempts, the hammer breaks the nail and shatters the wood) that we engage with the world in a more reflective or thematic stance, thinking about what has happened and how to proceed forward (Yanow and Tsoukas, 2009).

As I have argued earlier, given the low occurrence of total breakdowns in systems it is remarkable that organizational scholars have put so much emphasis on breakdowns as disasters and crises (Boin and McConnel, 2007; Comfort, 2007; Kayes, 2004; Klinenberg, 2015; Perrow, 2011; Turner, 1976; Vaughan, 1997; Weick, 1990, 1993, to name but a few). Perhaps once we take into consideration disaster’s often dramatic consequences this observation becomes less so remarkable, but in the context of complexity the privilege given by organizational scholars to such crises is problematic: it implicitly treats the breakdown in the system as fundamentally different from the functioning system. In other words, the breakdown is given a different ontological status than the infrastructure, and the mismatch between the two should be causally related to account for what has led to the breakdown. Complex systems, from such a perspective, become something where complexity in the end should be resolved. The two ‘conditions’ of infrastructure are set apart and then analyzed. With a focus on breakdowns as ‘daily disruptions’, however, this dissertation has shown that the infrastructure and the breakdown are inseparable; understanding the temporality of systems, so I have argued, is necessary to understand its underlying complex dynamics.

This dissertation, then, does not try to resolve the complexity in systems but, on the contrary, aims to account for the complexity of a system in order to dissolve the distinctions made between the infrastructure as operating and the infrastructure as broken down. I do not suggest that infrastructure breakdowns do not exist but that we must focus on those coping strategies through which (organizational) actors deal with the complexity in their infrastructure. Making distinctions between the infrastructure and the breakdown is a non-
complex way of understanding the system. It involves a way of reasoning that finds it difficult to account for the inherently paradoxical nature of social reality, for example in terms of the organization as a stable object and simultaneously organizing as an indeterminate and always changing process (Farjoun, 2010; Lewis, 2000; Tsoukas and Chia, 2002). Once we take stability as the norm (i.e. it either works or not) it becomes increasingly difficult to understand the inherent fluidity of the world. In sum, my dissertation has advanced an understanding of the management of complex systems that is sensible rather than reductionist to paradoxes and tensions, thereby offering a more complex articulation of what constitutes complexity in organizational systems. In section 8.5 I will offer two suggestions in which the temporality of infrastructure breakdowns can be further explored.

8.3 Theoretical implications for organizational complexity

Following from the above discussion, another contribution of my dissertation revolves around the literature on organizational complexity. This contribution specifically emerged from the chosen practice-based approach and suggests this is an interesting way for future studies on complexity. As has become apparent in the empirical chapters, such an approach is valuable in understanding organizations as an interrelated and entangled whole – that is, as a complexus – that cannot be reduced to a priori properties of the system. In fact, as I have illustrated, coping with complexity in order to categorize a system through pre-established representations in pursuit of establishing order or controlling potential disorder brings forward a new form of dynamics. My dissertation contributes to an enhanced understanding of organizational complexity, showing how instances of practicing, coping, organizing, and managing always happen on the boundary of abstract representations and actual situations. This can be elaborated by explaining how organizational complexity is materially, relationally, and performatively constituted in how people cope with complexity.

8.3.1 Entanglements of complexity in practice

In line with recent advances in the literature on sociomateriality (e.g. Carlile, Nicolini, Langley and Tsoukas, 2013; Latour, 2005; Leonardi and Barley, 2010; Orlikowski, 2007; Orlikowski and Scott, 2008; Suchman, 2007), this dissertation shows how we can understand organizational
life as a complex whole in which the social and material world are inseparable. What I at various points have referred to as ‘maps’ – i.e. those abstract representations through which the Dutch railway organizations aim to tame a complex railway world – should now be understood as actual material instantiations. Thus, the performance indicator, the design of the OCCR, or the code T.I.S. 3.1, are not mere ideational or symbolic tools that represent the work of railway employees.

As Barad (2007, p. 66) argues, representations have materiality that goes beyond the idea of physicality, as representations can indeed produce or ‘materialize’ certain abstract ideas into reality. In other words, when discourses or symbols have an actual effect on the reality they describe (i.e. they cause a change or shape our beliefs), they become materialized. This may sound like highbrow theorizing but is, in fact, very concrete when looked at in practice. The performance indicator punctuality in the OCCR is sociomaterial in the sense that it not so much neutrally represents the punctuality of the railway service but produces the circumstances for changing the practices in the OCCR in order to become more punctual. In other words, the map in this case is not an intermediary that, much like a mirror, neutrally reflects the work of coordinators but, on the contrary, acts as a mediator that multiplies differences into the world (Barad, 2007; Haraway, 1997; Latour, 2005). This shows that the map and the territory are inherently related, and in this dissertation I have sought to illustrate this by accounting for the railway infrastructure as an entangled and inseparable system. The three scenarios I have sketched contribute to a deeper understanding of the sociomaterial relations between representations and practices in order to account better for the different ways in which organizational actors cope with organizational complexity in specific situations.

Moreover, and this would be an implication for the literature on organization and management studies in general, I have also shown the inseparability of representations and situations, maps and territories, or ‘coping with complexity’ and ‘organizational complexity’. As Cooper (1986) states, we enframe or draw boundaries around our systems and this allows us to explain that what falls within as the orderly system and that what falls outside as a disorderly environment. Drawing boundaries between ‘things’, however, not only separates them but also unites them; A is different from B but A, as a consequence of its separation, is also only explainable in terms of B. The binary man/woman division, for instance, shows not just difference but it also shows their relation and thus conceptual inseparability (i.e. the concept ‘man’ is only meaningful in relation to its conceptual counterpart ‘woman’).
Cooper’s arguments implicate that scholars studying organizational systems should focus on the relationality of the ‘things within the system’, arguing for their entangled nature: boundaries are not things in themselves and neither only the outcome of representational attempts to map a territory, but they are a matter of difference, producing how we perceive and experience the map as well as the territory, order as well as disorder.

The relational quality of organizational systems, finally, also highlights the performativity of representations. Tsoukas (2016), in arguing for an enhanced – i.e. more complex – way to understand organizational complexity, posits that we should cease interpreting organization as a trivial machine in which input and output are causally connected with a fixed and pre-determined rule. He argues to imagine organization as a non-trivial machine, where output is dependent on history, agency, and intentions: the ‘output’, and this is much in line with a practice-approach to complexity, is shaped by the rule but simultaneously the rule is shaped by the process. Thus, representations do not give us unmediated access to an organizational world but they actually produce a difference into that world (see also Bateson, 1987). Representations are, so to speak, performative in the sense that they change the world – non-determinately – into the descriptions that they make of that world (Barad, 2003; Keevers et al., 2012; MacKenzie, 2006).

Although it may still be a somewhat speculative conclusion, the insights from this dissertation invite us to rethink organizational complexity in a crucial way. If, i) complexity is informative about our ways of thinking about a system instead of the inherent quality of that system and, ii) our description of the system is always an inaccurate or incomplete way of representing it and, iii) these descriptions are performative by producing differences within the system, making the system resemble the description, then, iv) are we in the attempt to reduce complexity not actually creating complexity? Are the paradoxes that our theories try to avoid not actually created in practice? If taken to the extreme, an image emerges that remarkably resonates with the story of Frankenstein: we are conquering Monsters created by ourselves. Complexity, rather than a fundamental state of that what we try to organize and manage, is, de facto, made in and through our maps. As discussed, this may be an unavoidable consequence of us humans making sense of ‘raw’ experiences. But, notwithstanding, such questions must be explored in terms of its practical implications.
8.4 Implications for practice

Complexity, representations, sociomateriality, performativity; theoretical concepts to make sense of a research that was conducted in a very practical setting. The concepts obviously reflect my own interpretations of what I have observed, heard, learned and read during my time at the Dutch railway organizations. Sometimes, however, my research was also guided more strongly into a particular direction while engaging in conversations with railway employees. It was a sunny and late afternoon in the summer of 2015 that I sat in Rick’s car. Rick, a junior manager at the emergency service department invited to bring me home, since we live close to each other. It was busy on the road that day, perhaps because the weather was so nice and people were out and about to meet friends at the beach or at a nearby lake, and we got stuck in a rather tedious traffic jam. For an hour we discussed many different things, from our personal lives to the railway world, and together we philosophized about the future of the railways. That evening, just before going to bed, I received an email from Rick: ‘Thijs, after today’s conversation I wanted to recommend you one of my favorite books. Please read “Antifragile: Things that gain from disorder” by Nassim Taleb’. Triggered by the title I bought the book and read it in the next few days. Taleb defines ‘antifragility’ in the beginning of his book as follows:

Some things benefit from shocks; they thrive and grow when exposed to volatility, randomness, disorder, and stressors and love adventure, risk, and uncertainty. Yet, in spite of the ubiquity of the phenomenon, there is no word for the exact opposite of fragile. Let us call it antifragile. Antifragility is beyond resilience and robustness. The resilient resists shocks and stays the same; the antifragile gets better (Taleb, 2012, p. 3)

The quote reminded me of some of the work of anthropologist Tim Ingold, and especially in relation to his remarks about the difference between ‘surprise’ and ‘astonishment’. According to Ingold (2011, p. 74-5), those who live by means of rational enquiry and prediction in order to understand life do so from ‘within a grid of concepts and categories’, and they are surprised when unexpected events happen. Those who are open towards the world, on the other hand, will never be surprised by unexpected events but are ‘perpetually astonished’, and this means to be vulnerable as well as strong: ‘[astonishment] allows them at every moment to respond to the flux of the world with care, judgement, and sensitivity’.
At the heart of this research are questions that are reminiscent of (anti)fragility, surprise and astonishment: how can we live and organize a life that is inherently indeterminate? In the empirical chapters we have seen ample examples of successful and sometimes less successful attempts to tame a complex railway world. How, then, can this dissertation inform the management of infrastructures in general and those of the Dutch railways in particular? The results of my dissertation seem to suggest that the railway organizations need to find a delicate balance between being in control but in a flexible way. Maps may help to make sense of the complex railway territory, but they can also suffocate practice and, thereby, lead to less openness to flexibly respond to unexpected events in the world. Based on the findings in the empirical chapters I will now discuss four practical implications that may help the different actors in the railway organizations to strike this balance between control and flexibility whilst coping with complexity. Since these implications are suggestions to deal with an indeterminate and open world, they are by necessity open and indeterminate implications. In fact, as I see it, one of the greatest challenges for the Dutch railway organizations is to find ways to cope with openness – i.e. not by means of closure but by truly appreciating the complex nature of its infrastructure that is always on the move. The first three recommendations are directed at the Dutch railway organizations but also suggest implications for other infrastructure or network managers (e.g. telecom, gas and electricity, data managers, highway networks, etc.). The fourth recommendation is specifically aimed at those governing bodies or regulating authorities whose decisions are of direct consequence for how the railways are managed.

8.4.1 **Design more complex maps that leave room for professional judgment**

Maps (e.g. procedures, rules, performance or process indicators, handbooks, agreements, plans, evaluations) can be useful tools to deal with infrastructure breakdowns. But one should be constantly aware of the fact that they are representations, and nothing more and less, of the infrastructure. Failing to do so may lead to situations as sketched in scenario 3, where maps take over the territory to such an extent that we end up in a world of simulation: rather than managing punctuality we are managing the indicator; instead of clearing the tracks from a body we are clearing the situation to fit into a code. To avoid such simulations means to be aware of the potential unintended consequences of maps during their design. For instance, the current rationalizing project at ProRail is called ‘Pre-defined Solutions’, and this promises to think through every possible disruption that can take place on the railways in order to
Design ready-made solutions that are immediately available for coordinators once a specific breakdown occurs. This begs the question: is it really possible to think through every possible breakdown and every possible parameter (e.g. rolling stock, available infrastructure, location, time, weather circumstances, etc.) that may affect the breakdown in every possible way?

This question should not be answered just for the sake of the answer. What is more important is that such questions can inform how maps – such as ‘Pre-defined Solutions’ – are designed. Sure, maps can be a great tool for coordinators to make sense of specific situations; coordinators, too, may very well be incapable of coping with all the factors that shape a specific disruption. Rather than maps that seek closure to account for an inherently indeterminate world, so I would argue, maps should provide openness in the sense that they support instead of restrict coordinators in making professional decisions in specific situations. Rather than fighting openness with closure this means to embrace openness with more openness. This requires designing maps that do not dream of a simple railway world and neither ones that fear a chaotic one; the railway system is a complex system and this requires complex ways of coping – in the interplay of maps and territories – with situations. It should be applauded, for example, that the indicator punctuality at this moment is increasingly developing from measuring the punctuality of trains towards the punctuality of passengers. This may eventually support coordinators in making professional decisions and judgments about the whole railway system (i.e. coordinators can decide to delay a specific train to improve overall punctuality), as it takes into greater account that what the indicator measures better reflects that what it really wants to know and, eventually, improve.

8.4.2 Learn to reflect on new dynamics introduced by maps

The design of maps is just the starting point. As I have shown, maps are performative as they introduce new dynamics within the territory, and some of these may be considered as beneficial and others as unintended or surprising. Maps should thus continuously be under scrutiny in order to keep checking and evaluating their effects. This requires a collective kind of reflection that involves a broad representation of the different layers of the organization, ranging from management and staff to coordinators and train drivers.

Reflecting on maps also, perhaps somewhat paradoxically, requires a starting point that does not take the maps too seriously. A danger when reflecting on maps is that this reflection happens based on the logic that is inscribed in the map, and this would reinforce
this logic rather than explore what we can learn from it: the map is seen as an end in itself rather than a means to reach a particular end. Thus, questions should be asked that really try to unravel the map and its consequences: What do we want to reach through this particular map? How does it do so? To what extent does it support or restrict the practices of employees and is this desired? How are practices ‘in the territory’ changed by this map, and can we account for these changes in reference to the map only or also in relation to what we want to happen, change, or improve in the territory? How do practitioners think about these changes and what are their suggestions?

As a concrete example, the railway organizations are now establishing an ‘OCCR 2.0’. They have concluded that certain promised effects of a co-located coordination center, the ones I have described in chapter 6, have not yet been effectuated in the short history of the OCCR. Alongside a general restructuration of operational practices, the processes and spatial setting of the building are now being changed. This change should be seen as the making of a new map, and truly reflecting on what such a map may potentially change in desired or undesired ways means to critically assess it from design up until and including the actual use of the new space. What happens, for example, in the OCCR 2.0 in terms of collaboration and territoriality? As chapter 6 of this dissertation suggests, it may very well be a combination of both, and critically reflecting on this process may help in continually fine-tuning not only the map but also the effects that the map (should) have on the territory.

8.4.3 Do not forget to focus on ‘daily disruptions’

As I have argued in this dissertation, to truly understand infrastructure breakdowns it is insufficient to only focus on those breakdowns that are considered as one with an especially large impact (e.g. national system disruptions, derailments, head-on train collisions). By all means, these breakdowns have to be evaluated and people should do everything within their reach to prevent similar breakdowns in the future. But focusing on such disasters only at the cost of ‘daily disruptions’ is problematic for three reasons. First, it implicitly treats the breakdown as ontologically different from the infrastructure. As I have tried to argue, the two are not so much distinct but intimately related: infrastructure is a recursive process that is, in one way or another, continually breaking down as well as in repair. Thus, treating breakdowns as exceptional runs the risk of taking the exceptional as a source of learning and improvement while taking the ‘normal’ (the infrastructure functions as we expect it to) for
Discussion and conclusions

granted. On the other hand, if we take the ‘normal’ as a serious source of learning as well, we can get to understand how the normal is not so normal at all: there resides a whole world of work behind the functioning of an infrastructure.

Second, giving the exceptional privilege in terms of evaluations and learning implies that the exceptional becomes a source of change and improvements for the normal, too. But how do such changes affect how people deal with daily disruptions? Large breakdowns may be so exceptional precisely because breakdowns are in most of the cases already absorbed in practice while coordinators and technologies together are coping with daily disruptions. Much can then be learned when we evaluate not only what went wrong in this specific case but also why, in the large majority of cases and despite of the complexity of the system, things often do not go wrong. This should not be done in an uncritical way and is not meant to celebrate the infrastructure but, instead, it should be used as a critical and in-depth way of learning from the normal. Third, taking the exceptional as a point of departure in evaluating how the infrastructure functions involves a danger as it implicitly says we can imagine a world where, through increasingly more sophisticated management techniques, the exceptional can be dreamt away. This is dangerous as it suggests that we can know the world thoroughly and that we can predict the events in our world completely. But of course, there are many things we do not, cannot, and perhaps even should not know; it are these ‘unknown unknowns’ that will happen, sooner or later.

Being truly open to the world does not mean to simply accept disastrous breakdowns as ‘unavoidable’. But it neither means to take the mundane ‘daily disruptions’ as insignificant. It requires, in Ingold’s words, the strength to be open to an astonishment ‘that comes from treasuring every moment, as if, in that moment, we were encountering the world for the first time, sensing its pulse, marveling at its beauty, and wondering how such a world is possible’ (2011, p. 64). We can learn a great deal from every turn the world takes. I have tried to illustrate so in this study by, contrary to ProRail’s initial instructions to focus on large system breakdowns, arguing that the at first glance harmless daily organizational life may very well be that which slowly secretes its venom over the railways.
8.4.4 Governing bodies and regulating authorities: your efforts also create complexity

As I have briefly illustrated in section 1.2 of this dissertation, the Dutch railways has, since its inception in 1837, been under great control of the Dutch government. Surely, the organizations have been set at a greater distance with NS being a private party – with the government as only shareholder – and ProRail as a public independent body (although the future of ProRail in term of independence is uncertain at this moment). At the same time, both organizations are still intimately governed and steered through concessions, performance indicators, fines, or threats to renationalization or to undo the split between ProRail and NS. Perhaps the proliferation of abstract maps within the railway organizations that aim to cope with complexity in its system can be interpreted as a result from the organizations being situated in this ‘in-between’ state: operating independently while being dependent on the government; instrumentally operating on a market while having to guard public values; flexibly or pragmatically responding to specific situations while always under the guise of being in control and while having to legitimize each and every choice.

In a sense, I believe that the difficulties of managing the railways are also informative for the difficulties to govern or regulate those managing the railways. For the Ministry of Infrastructure and Environment, for instance, it is as important to learn how to deal with paradoxes, organizational complexity, or the indeterminateness of the world. However, not responding to these difficulties in an open way but by means of seeking closure (e.g. through performance indicators) can be interpreted as an attempt to delegate these difficulties to others in order to avoid taking responsibilities. In fact, we can also see these attempts as a matter of creating or adding complexity to the already complex railway system; agreements or new rules and procedures are, rather than being tools to practically engage with (or not), increasingly becoming ends in themselves in order to satisfy what the authorities want by means of abstract maps rather than concrete situations.\(^\text{22}\)

\(^{22}\) A more cynical reading could also argue that it may very well be the case that it are exactly these maps that allow the railway system to operate in the first place. It are these multiple rules and procedures that allow the railway organizations to navigate a complex territory by creatively circumventing many of these rules and procedures. For instance, as Gouldner (1954) argues in his treatise of a ‘mock bureaucracy’, bureaucracies may sometimes create complexity simply in order to manage complexity: more rules means more deviations and room for maneuver.
8.5 Directions for future research

Like the processual ontology developed in this dissertation, the book does not end here. This study began where other have ended and ends where others may begin. Below I offer four suggestions for how this dissertation may inform future research on organizational complexity. In line with several others (Chia, 1998; Morin, 2005; Prigogine, 1989; Tsoukas, 2017; Tsoukas and Hatch, 2001), I believe this should happen from within a discourse that is complex enough to truly appreciate what it means for something to turn up as complex.

First, I would suggest that the temporal nature of infrastructure breakdowns need to be understood more profoundly, and I see at least two ways through which we could do so: employing a long-term historical perspective or a short-term phenomenological perspective. To elaborate the former, a historical perspective on infrastructures looks at the continuity of infrastructures. Continuity, here, does not so much refer to stability but rather to the continuity of a system despite its changing nature and its breakdowns. It does not see a breakdown as an immediate break of the system in the here and the now, but it traces how infrastructures have evolved over time in the long run and it investigates where they might be heading. As Howe et al. (2016) have argued, we can understand infrastructure through the paradox of ruins and retrofitting. Infrastructures may become obsolete and unused, but most often they form the source or foundation for a next generation of infrastructures. For instance, New York’s High Line Park and Singapore’s Green Corridor illustrate how old and deserted masses of railway lines have been retrofitted into new infrastructures fitting recreational purposes. The railway infrastructure has not so much gone to waste as that it has become a part of another infrastructure, both in the sense that it is still materially there as that it has acted as the – literal and figurative – foundation of the new infrastructure. Such an historical perspective may also imagine how future and even digital infrastructures will be a retrofitted version of old ones. Hu (2015), for example, traces the virtual infrastructure of the ‘Cloud’ to be located in actual material settings of old infrastructures such as abandoned railway track and sewer systems.

Second, the short-term phenomenological perspective finds temporality in the present practices of people organizing, operating, or using the infrastructure. As I have argued in chapter 3, practices, although taking place in the present, are always shaped by past experiences and future expectations. As such, practices connect the different ‘states’ of an infrastructure (ranging on the continuum between functioning and broken down) in the here-and-now. Thus, rather than focusing on the breakdown as an anomaly or unwanted disorderly state, much can be learned when turning to the life-world of practitioners and
how they cope with breakdowns in practice. Such breakdowns as ‘daily disruptions’ draws attention to how people, from the midst of action, notice deviations in their systems and decide to act upon it or not. Such a perspective aims to study in-depth how organizational life unfolds as it unfolds, rather than accounting for certain situations in a retrospective sense. It is sensitive to the experience of practitioners in order to understand how the system is always in a state of repair and maintenance rather than fixed and orderly (Graham and Thrift, 2007; Henke, 2000), and this shows the many ways in which work, in the face of potential or actual breakdowns, may come into being (Yanow and Tsoukas, 2009).

Third, if we can truly begin to understand organizational complexity as the product of our own interventions in the world, then we need to reconsider what it means to live in a world that is in principle indeterminate. This would involve several questions that, most probably, can best be answered from a philosophically informed perspective. How, for example, can we start to embrace complexity and how can we see complexity as a quality of organization rather than something to be fought? If we begin to see order and disorder as the different sides of the same coin (Cooper, 1986), then can we also imagine ways through which we may befrend the Monster we encounter or accept the Mess we sometimes see? Such questions can especially trigger research that speaks more specifically to the domain of organizational studies, as it could be an inspiring spark to think of management in new ways. Are ‘organization’ and ‘complexity’, for instance, really and necessarily so an oxymoron (Chia, 1998, p. 362)? Is it even possible to manage by means of embracing complexity, and what would such management look like?

Finally, this study has been conducted in one specific system, and it has only been able to explore a part of this system. It would be interesting to see how coping with organizational complexity by means of abstract maps happens in different organizational, institutional, cultural, or even national contexts. If there is indeed a difference in how people from various cultural backgrounds do or do not recognize and respond to specific paradoxes (Keller et al., 2017), then this could have implications for how situations in different contexts turn up as complex and how these matters are then dealt with. Moreover, a limitation of the present study is the fact that it has only been able to investigate a part of the Dutch railway system. ‘The system’ is in principle endless and it is a matter of where the observer or researcher draws boundaries between what seems to fit within the system and what belongs to the environment. Taking the vantage point of the broader system by, for instance, also taking into account political contexts, public discourses, demands that are set by other organizations and institutions, would be another way forward to complexify our language and our thinking about organizational complexity.