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Roman Solé-Pomies

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Re-negotiating infrastructural boundaries in urban spaces: road maintenance as a dualistic mode of infrastructuring

Roman Solé-Pomies

Centre for the Sociology of Innovation, Mines Paris–PSL

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Abstract

The ageing of urban networks in Western countries has long been simultaneously questioning public management and scholarly conceptions of infrastructures. It gives a particular relevance to the study of maintenance practices, which has developed in Science and Technology Studies in a problematization of the ontology of lasting artefacts. This chapter extends these discussions drawing on the case of road management in French local governments. In an approach inspired by Mol's ontological politics, it first discusses maintenance issues as an opening of infrastructural boundaries, leading to a form of cross-sector management. Then, road maintenance appears as a mode of infrastructuring that relies on situated diagnoses to reconstruct the boundary between nature and infrastructure in urban spaces.

Keywords

Infrastructure maintenance; Ontological politics; Nature/society; Infrastructuring; Boundary-work; Public roads

The ageing of urban infrastructures in Western countries has been a matter of concern for a few decades, leading to vivid debates regarding public policies. Florentin (2016) recounts how the intervention of operators managing technical networks reshaped an urban renewal program in Eastern Germany, public authorities being then confronted with the shrinking of water and energy networks. Alm *et al.* (2021) use the concept of local capacity to analyse the challenges faced by Swedish municipalities as their road networks require more and more maintenance. Epstein (2013) has shown that French urban renewal programs were an occasion to re-negotiate relations between the state and cities. In these different instances, the ageing of urban infrastructures gives new responsibilities to local public authorities, bringing out the need for maintenance (Denis and Florentin, this volume). Considering these important shifts in local government, an interesting line of analysis developed in STS has consisted in questioning pre-conceptions of infrastructures themselves. Hommels (2005), for instance, has explained how different STS approaches, tackling the complex interplay of technical, political and economic challenges, could fruitfully address urban policies, and more precisely urban planning, by discussing the obduracy of technical networks. This echoes the concerns of a growing body of literature investigating infrastructures “in process” (Barry 2020), subject to dynamic collective action as they age and transform. Taking one step further in this political problematization of the variability of infrastructures, maintenance studies have discussed the coexistence of different relationships to infrastructures, some of them—especially those involving maintenance work—entailing greater awareness of their material fragility than others (Graham and Thrift 2007; Edensor 2011; Denis and Pontille 2015). This chapter extends these debates by discussing how the ageing of urban networks, a growing concern for local authorities, raises ontological questions, addressing what an infrastructure *is* to different people. This ontological issue notably translates into difficulties and discrepancies in the ways the boundaries of these particular technical objects are apprehended in maintenance practices. Edwards (2002) has approached infrastructures as the material substrate of modern thought, notably as they introduce distinctions between natural and artificial environment; this contribution proposes a theoretical framework to investigate how this substrate is maintained in time. Ultimately, paying attention to the boundary-work at play in maintenance brings to light specific ecological implications of these ordinary practices.

Recent debates about road policies in France provide a good illustration of the entanglement of public responsibility and assumptions regarding the life of infrastructures. Around 2010, the French state withdrew its technical support to local governments. Since then, the discourse of roadworks companies, which have long been involved rather in road construction, has increasingly revolved around the need for upkeep efforts on a regular basis. These companies and their partners have been expressing growing concern regarding the poor management of existing public roads, especially their maintenance. The revision of responsibilities regarding the management of roads and their fragilities will here be discussed as questioning the material boundaries of infrastructures themselves, drawing on a twofold ethnographic inquiry. On a national level, trade associations of roadworks companies and their partners question road policies through lobbying, research, and other communication activities. In local governments and administrations, similar debates are raised by technicians and operatives, in everyday road management; the study focused on twelve territories, including mostly small cities. I conducted seventy interviews with various actors, observed their daily activity, and reviewed public and internal documents.

The first section highlights the interest of investigating maintenance issues within a theoretical framework inspired by Mol’s (1999; 2002) ontological politics: as they destabilize infrastructural boundaries, debates surrounding the decay of roads simultaneously question urban policies and the ontology of urban infrastructures. To understand how these tensions are

managed, we then turn to the study of maintenance practices, emphasising their role as a situated ordering process in urban ecosystems.

Road Fragility and the Opening of Infrastructural Boundaries

In recent years, the ontology of infrastructures has been questioned in general ways. In his review of anthropological literature, for instance, Larkin (2013) starts from a very broad definition of infrastructure as “built networks that facilitate the flow of goods, people, or ideas and allow for their exchange over space” (328), to conclude “Their peculiar ontology lies in the facts that they are things and also the relation between things” (329). In contrast, Jensen and Morita propose to “view infrastructures as *emergent systems that produce variable practical ontologies*—novel configurations of the world and its elements” (2015, 84, emphasis in original). These remarks do not, however, respond to our specific concern with infrastructure maintenance as part of urban ordering processes. As suggested by Sismondo (2015), it is then useful to take the description of practical issues as a starting point to discuss the ontologies of artefacts, what Lynch (2013) calls “ontography”.

The ageing of roads raises debates regarding the right ways of conceiving and monitoring roads, and making them last. In this context, focusing on maintenance problems reveals infrastructures as embedded in complex ecosystems, to the point of questioning infrastructural boundaries.

Maintenance as Ontological Politics

Since the French state withdrew most of its technical support to regional governments, roadworks companies have been expressing growing concern regarding the local management of infrastructures. They particularly advocate for preventive maintenance. Local elected representatives allegedly tend to wait until roads are severely damaged, before completely refurbishing them. This is said to be ineffective from an economic as well as environmental standpoint, considering energy and materials consumption as well as carbon emissions. Instead of waiting for potholes, one should regularly maintain the upper layers of roads so as to preserve their impermeability, thus protecting the lower layers from damage by water infiltrations (Routes de France 2018). This debate is clearly a matter of public policy, but at the same time outlines different *versions* of what infrastructure is. In the first version, which I will call the *breakdown-and-repair version*, a road is just a surface enabling safe traffic, but that can occasionally fail to do so, then requiring repair work to restore its normal functioning. In the second version, roads have different properties: their several layers interact, and even when the upper layers enable safe transportation, their cracks can indirectly damage the lower layers. This I will call the *maintenance version*.

As they consist in deciding what makes or keeps a thing the same, maintenance choices have already been analysed as ontological statements regarding what traits define their object (Denis and Pontille 2015). Of course, maintenance operations transform infrastructures, contributing to their future state. However, as their point is to make an infrastructure stay the same—if in different states—, they decide what characterises it fundamentally, thus putting in tension different *versions* of infrastructures. The vocabulary of “versions” comes from Mol’s “ontological politics” (1999; 2002). In Mol’s work, the ontology of a disease partly results from political choices in our ways of enacting it; in the case of anaemia (Mol 1999), different

versions come with a different relative role given to market and state in public health policy. This approach has been of broad influence in Science and Technology Studies, as part of what scholars have debated as an “ontological turn” (Sismondo 2015; Woolgar and Lezaun 2015; in this debate, see also Lynch 2013). It presents the interest of taking the different rationalities at play in interactions with technical objects equally seriously. In the case of infrastructure, more classical approaches aiming to discuss good management, for instance as they assess the value of infrastructure to optimise the balance between maintenance expenses and new infrastructure investment, are missing the reasons why all managers do not implement such rational policies, and they sometimes acknowledge it: “it remains somewhat of a puzzle why maintenance has been neglected in industrial countries as well as in developing countries” (Rioja 2013, 361–62). The puzzle might be solved if we fully consider what infrastructures *are* in a given management situation. As long as infrastructures function without breakdown, it is easy to neglect maintenance (Star and Strauss 1999) because they do not operate as something currently fragile, but only as systems that might later break down and then need repair. This version could be destabilised by specialised diagnoses that would reveal the hidden fragilities of structures, but the investment in such diagnoses itself is absurd in this version; furthermore, even if it were performed, the need for preventative maintenance could still be debated, the two versions then starting to conflict. This complexity also explains the interest expressed by roadworks companies, and their partners, for an empirical inquiry into infrastructure management practices at work in local governments.

An ontological politics approach to infrastructures acknowledges the important work needed to bring the maintenance version to existence. It can also address the need to move beyond the traditional analytical focus on breakdown in STS, already pointed out by maintenance studies:

“Traditionally, breakdown is considered as a univocal event that both changes radically how users deal with things and offers to the researcher the conditions needed to bring hitherto unnoticed aspects of the world to light. The diversity of maintenance regimes may help to decenter such a view, and see breakdown as a relational phenomenon enacted in distinct manners across the various sites and circumstances in which it operates.”

(Denis and Pontille 2017, 6).

The mere focus on breakdown misses the constant work invested in maintaining infrastructures, and the constant attention some people—maintainers—develop, without waiting for breakdown to happen (Graham 2010). The need for preventative maintenance, however, is not always obvious, as noted for instance by Chatzis (2008) in his studies of the rationalisation efforts for preventative maintenance in French post-war industry. Regarding roads, national institutions distinguish three types of interventions: ordinary upkeep that consists of limited curative activities, planned preventive work that focuses on the upper layers in order to protect the deeper structure of the road, and heavy refurbishment work, closer to replacement, once major damage has occurred (IDRRIM 2016, 24). Trade associations of roadworks companies then focus part of their lobbying effort on raising awareness among road managers of the concept of “grey debt”. This phrase expresses the idea that, as roads tend to decay quicker and quicker, a lack of investment in early maintenance later results in increased costs, as classically illustrated by the so-called resilience curve (Figure 1).

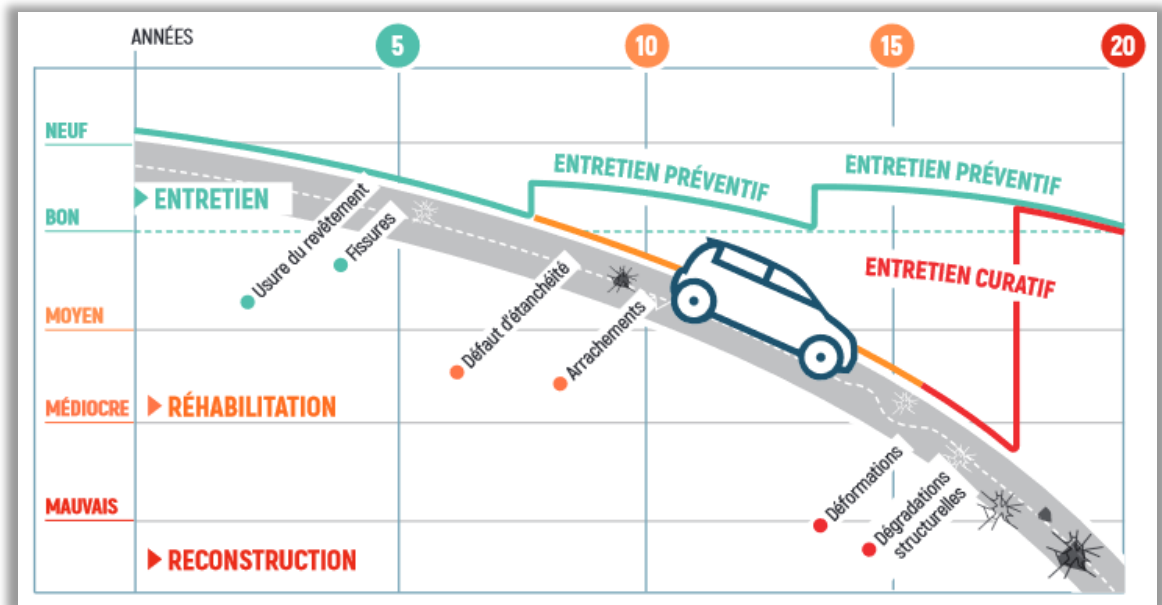


Figure 1. An illustration of the need for preventative maintenance. The x axis represents time in years. The y axis represents the state of the road, associated with the kind of operations needed: “new” and “good” associated with “upkeep” (green), “medium” and “mediocre” along with “refurbishment” (orange), “poor” leading to “reconstruction” (red). The road illustrates the tendency to decay with examples of damages (inclined words along the road): “wear and tear,” “cracks” (green), “lack of impermeability,” “removal of materials” (orange), “deformations,” “structural damages” (red). The curves themselves illustrate possible policies. The first one maintains the road in good state, repeating “preventative upkeep”. The second one goes down until coming to “curative upkeep.” The differences in height represent the increased costs due to late interventions. Source: Routes de France (2018, 16).

The management of these different, arguably complementary, modes of interventions can be interpreted in the terms of the two versions of roads outlined above, this diagram acting as an advocacy for the maintenance version. In a caricatural breakdown-and-repair version, one simply waits until users report a pothole or a deeply damaged road. One of the main difficulties that maintain many road managers in this kind of action is a lack of financial resources to engage in preventive actions, compared to the constant, urgent needs for curative interventions. In the maintenance version, regular surveillance of road symptoms is required. What counts as roadworks is not the same: only in the maintenance version do certain preventive techniques make sense, for instance those aiming to preserve the imperviousness of upper layers. This approach in terms of ontological politics can be of particular interest to urban studies, as it enables to grasp simultaneously debates regarding public policies as well as different conceptions of infrastructures.

Thickening Ontologies

The advocacy for preventive maintenance can be understood as an invitation to literally thicken the ontology of infrastructures, by adding layers to it. Roads should not be treated as mere surfaces interacting with vehicles, but as thick systems involving internal interactions between different material layers, vehicles, as well as precipitations. This is both a way of considering certain infrastructural problems, such as the need to impermeabilise upper layers in order to preserve the deeper structure, and making sense of maintenance work. In this view, the ethnographic account that takes maintenance operations seriously repeats the gesture of thickening the ontology of roads operated by the advocates of preventive maintenance. To make sense of an apparently simple maintenance operation, the ethnographer comes to produce a “thick description” (Geertz 1973). An ordinary operation observed in my fieldwork should be recounted as follows: *the worker repeatedly used his own weight to test the anchoring of the sign in the ground, because he explained that the declivity of this road shoulder regularly led to an accumulation of snow that could destabilise the post*. The thickness of such a description is that of the network of material elements composing the infrastructure in relation to its environment, as made sense of by maintainers. An interest of ethnographic work is that it leads to thickening the ontology of roads, thus accounting for issues that other versions tend to neglect.

At the same time, this thickening effort gives the people advocating for it a particular role in public debates. Engineers and managers thickening infrastructural ontologies are specialists paying particular, informed attention to infrastructure and its fragility, people caring about infrastructures. Relationships between attention, maintenance, and care have long been studied. Closely observing urban maintenance operations dedicated to prevent serious breakdowns, Denis and Pontille (2020) show how workers develop specific forms of corporeal attention to their object, relying on different senses. These forms of attention are characterised by a focus on material fragility as the starting point for action: maintenance appears as a “care of things” which stands out from the usual assumption that considers material stability as a precondition for the production of socio-material order (Denis and Pontille 2015). Drawing on an investigation into artworks maintenance, Domínguez Rubio (2016) highlights the intensive, often invisible care needed to sustain the appearance of stable “objects”. This unequal attention to the fragility of things has concrete consequences. In a domestic context, Gregson *et al.* (2009) have discussed how care brought to an object such as a dining room table can in turn change the forms of attention it is subject to, fostering further care from the whole family out of respect for the maintenance work achieved. It is then clear that people taking care of things, as they pay particular attention to their fragilities, can come to play a particular role in the production of material order.

The production of ontologies through maintenance issues, and through the particular forms of attention associated to the formulation of such issues, has been investigated for several years within maintenance and repair studies, as explicitly discussed by Denis (2018): as maintenance practices strive to preserve either their object’s shape, material composition, authenticity, or rather its good functioning, they entail permanent normative operations, constantly enacting what this object is. In the case of roads, favouring preventive maintenance over curative treatments puts in tension more or less thick(ened) ontologies. These choices are political as they have two symmetrical types of implications: on the one hand, they suppose a certain organisation of collective work, a certain distribution of responsibilities, a certain ecology of attention; on the other hand, they have consequences for the state of infrastructures, hence the possible uses of networks and choices regarding public expenses.

The notion of “ontological politics” is a way to grasp the interplay of these various political issues intertwined by collective choices on what things are and do.

Questioning Infrastructural Boundaries

To illustrate more concretely the thickening of infrastructural ontologies by people advocating for maintenance, let me mention a situation encountered during an ethnographic inquiry in a small town. As I was discussing the kinds of operations I could observe with the city’s technical services director, he invited me to go and see a team busy with tree pruning, arguing “tree pruning *is* part of roadworks”. As explained to me later, this often-neglected activity is dedicated to preserving exposure to sunlight, which is essential for roads to dry and suffer less from water infiltration. This example is characteristic of argumentative efforts made by the advocates of preventive maintenance, who have to *bring to light unexpected interdependencies*. This is also clear in documents giving prescriptions for good infrastructure management, which draw attention to the numerous annexes, such as ditches or pavements, affecting the fate of roads. These annexes can be referred to as “*équipements*” (Routes de France 2018, 8), “*accessoires*” or “*dépendances*” (AdCF and GART 2018, 13–14), the latter term conveying the sense that roads’ good state and usability depend on many, seemingly external elements. This matches a major result about invisible work from Star’s classical analysis of infrastructure: in usual interactions with technical artefacts, some crucial interdependencies go unnoticed. Typically, the importance of maintenance tends to be underestimated. In other words, the disregard to certain interdependencies restricts “what counts as work” (Star and Strauss 1999). In response, highlighting complex interdependencies is a way to extend the range of acknowledged work. However, while Star’s contribution is often rendered in terms of infrastructure’s invisibility (e.g. Barry 2020), visibility is not the main issue here. As opposed to underground networks, roads are recurrently said by technicians to be particularly visible to the attention of local elected representatives and populations.

The case for maintenance is thus not made by bringing to light the important role of roads, but rather an ever-extending network of interdependencies, a complex ecosystem in which roads are embedded. The focus on infrastructures as fragile, always in process, thus jeopardizes the possibility of a stable description of their material composition (Barry 2020). Infrastructural boundaries seem blurred as “the ontological in-betweenness of roads” is put forward (Rest and Rippa 2019, 383). Interestingly, while the embeddedness of urban infrastructures has been seen as an explanation to their obduracy (Hommels 2005), here it is rather a condition of their fragility, justifying the necessity of ongoing maintenance work. Edwards (2002) notes that, while modern thought has treated nature, society, and technology as “ontologically independent of each other”, their separation is constantly challenged in the concrete life of infrastructures—which raises the problem of maintenance. The blurring of infrastructural boundaries that follows, however, does not clarify the structure of maintenance policies; if anything, as the definition of the object to be maintained is obscured, it rather questions the relationship between maintenance and the urban order. How can road maintenance work be organised if it has to deal with practically everything in the city? This open question urges to shift from the study of debates on the contrasted roles of repair and preventive maintenance, to inquiries into situated maintenance practices.

Maintaining Infrastructural Ontology and Urban Order

As illustrated by other contributions to this collection (Carrière and Tripathy; Mouton) infrastructures actively participate in the production of urban order; but what happens when their ontologies are questioned? If debates on road management tend to embed infrastructure in an ever more complex urban ecology, the observation of daily maintenance practices confirms this extended perimeter of road management. Maintenance work appears as an ordering process constantly overflowing into its urban environment. In particular, it entails continuous diagnosis operations that point to its role as boundary-work, dedicated to perpetuate the integrity of infrastructures.

Road Maintenance as a Situated Ordering Process

In their day-to-day activity, maintenance workers involved in road management permanently interact with an ecosystem formed by a high diversity of indistinctly natural and artificial elements. The example of the driver of a street sweeper I accompanied in a small city is particularly eloquent: during his daily tour, he has to deal with various kinds of litter scattered across the streets, other vehicles more or less appropriately parked, restaurant tables, branches and brambles that could damage his machine... Moreover, he recounts how “everybody”—storekeepers, as well as his colleagues working nearby—calls upon him to come and clean their place first. This example illustrates the role of maintenance as an ordering process, a point that has already been made regarding other infrastructure systems. Denis and Pontille (2015) started approaching the specific status of maintenance as a care of things through the example of subway signs, and their role in the production of socio-material order. Wayfinding systems are considered tools for the production of order in flows, especially by their designers and by urban analysts who rely on the assumption of the signs’ stability. At the same time, in the study of maintenance practices, signs appear as fragile artefacts in situations in which these inscriptions divert from their powerful immutability. Maintenance then appears as a process that makes these two versions compatible, as it ensures that these signs that, on the one hand, are fragile and may fail can, on the other hand, keep ordering urban spaces. In this way, maintenance takes its part as an ordering process, necessary to the efficiency of other efforts such as the standardisation and strategic design of signs. This complementarity in ordering processes was further explored in the case of graffiti removal in Paris (Denis and Pontille 2021), envisioned by its managers as crucial to public order in the name of the “broken window theory”. Graffiti should be erased as their lasting presence allegedly acts as a sign that public spaces are out of control, which in turn could supposedly encourage their multiplication. The appearance of Paris should be preserved from such signs; but then, maintenance managers and workers face the problem of defining this integrity to be preserved. This problem, discussed as epistemological by the authors, is solved by a complex interplay of hierarchical directives and situated diagnoses, the role of which will be further discussed below.

In the case of street sweeping, what is at stake are small operations that discretely affect a broader urban order, due to the interaction of the many elements present on the streets also highlighted by Shaw (2014). These maintain both the appearance of cleanness and the possibility to circulate easily on the streets. This is why, while the sweeper’s work might be invisible to some people, for instance tourists, it is not to locals who are up and working around the public space in the morning, even though they do not specifically work on streets.

To them, the details of the driver's choices matter (on the political significance of maintenance choices, see also Paulsson and Alm, this volume). Such choices are indeed his own: there is no point in supervising in detail the sweeper's tour, which must adapt to everyday constraints. This points to an important result from maintenance and repair studies, namely the improvisatory character of maintenance work and its tendency to resist detailed planning (Orr 1996; Henke 2000).

Whether it preserves systems that direct flows of people, or removes signs that would suggest the poor management of public spaces, infrastructure maintenance participates in the production of urban order in many ways. It is necessary to the efficiency of planned policies; in this view, it cooperates with planning activities, obeying them to some extent and supplying them with information gathered on the field. At the same time, it partly resists planning because it constantly tackles unforeseen situations and problems. Infrastructure maintenance appears as an activity producing numerous small-scale political choices in the urban order.

From Diagnoses to Arbitrations

As emphasized in Henke's (2000, 66–69) seminal inquiry into repair work, resistance to planning is strongly linked to the permanent necessity for workers to diagnose and adapt to problems that may be unclear. In the case of infrastructure management, this aspect of maintenance is crucial because it contributes to the adaptability of infrastructures, which has been an important concern. Saxe and MacAskill's (2019) reservations about calls for adaptive infrastructures notably consist in highlighting the adaptability of existing, centralised infrastructure systems to “unplanned loadings, changes in technology, societal structure, and resource flows”—noting in particular that “In practice we have continued to need much of our infrastructure long past its original design life” (331). This is true in the case of roads, which fosters the interest of roadworks companies in practices of asset management. In their counter-response defending new policies for adaptive infrastructures, Chester and Allenby (2020) do not mention maintenance, repair, or asset management. Yet, such practices have long been making infrastructures adaptive. Maintenance and repair intervene long after initial design, taking charge of the need for improvisation and adaptation in the life of infrastructures. This determines the nature of the work confronted with an uncertain infrastructural world, and the role played by diagnoses. In Graham and Thrift's words, “When breakdowns and malfunctions occur, it is not necessarily the case that they can be easily fixed. The reason for the breakdown may be opaque (especially as technological systems become more complex), the restoration may be too urgent for usual channels and procedures to be followed, the replacement parts may not be quite right but need to be made to fit” (2007, 4). This depiction, however, does not completely account for the specificity of infrastructure maintenance in complex urban ecosystems: in particular, focusing on repair after breakdown, it does not address preventive actions.

Infrastructure maintainers produce spatial order in a messy environment. As highlighted by Edensor in the case of the preservation of a church, the problem of maintenance in the urban space can be characterised by the proliferation of “entangled agencies”. These are notably non-human life forms such as trees and biofilms, whose agencies must be acknowledged as they tend to damage human constructions (Edensor 2011). In their daily work, road maintainers actively diagnose such relationships of degradation, for instance when the sweeper's driver stops his machine to remove a bramble that could damage a joint. In the case of roads, these entangled agencies should also be extended to other infrastructure systems:

managers regularly regret the harm caused to roads by work conducted in underground networks.

In addition, infrastructure maintenance is not only dedicated to identifying harmful factors and preventing them from reaching the maintained object. In fact, this is almost never so simple in maintenance work more generally: even when the primary goal is to preserve an object's authenticity, operations are also framed by arbitrations regarding its uses. In the case of such a unique artwork as the Mona Lisa, for instance, Domínguez Rubio (2016) shows how some damage is accepted and managed for the sake of display. The same can be written about infrastructures, as illustrated by debates regarding heavy vehicles that should be forbidden on certain, fragile roads, but are still allowed for the sake of local economy.

In daily maintenance work, diagnoses do not necessarily consist in stating explanations for the state and symptoms of infrastructures. They often manifest as direct choices, which is fundamental to an approach in terms of ontological politics, considering action as the source of ontologies. In these choices, infrastructures themselves are not necessarily the object protected, as mentioned above in cases where harmful traffic is allowed; neither are they necessarily the object damaged. *Thickening the ontology of infrastructures supposes considering them in relations to other material elements.* Maintenance choices may thus cause damage to the equipment or maintainers' bodies: salt is used to fight snow and preserve the roads' usability, although it damages the roads themselves and the vehicles using it, including those used for maintenance; a street sweeper with poor shock absorbers is used to clean streets, although its jolting causes pain in the back of its driver. These side effects are often invisible, while they are typical of maintenance work—its physical arduousness being clear, for instance. *In the end, all maintenance operations are normative ones, as they enact arbitrations regarding what is harmful or useful to what, and what forms of use or interference should be accepted, managed, or fought against.* By means of such diagnoses and prescriptions, order is not only permanently restored, but also re-negotiated in the urban ecosystem.

Infrastructuring as Boundary-Work in Urban Ecosystems

As part of a growing interest for infrastructures “in process” (Barry 2020), the focus on maintenance contributes to renewing our view of the obduracy of urban networks in the sense of Hommels (2005), by putting forward the permanent efforts invested for the endurance of technical objects. As such, maintenance extends the process of “infrastructuring” in the sense of Karasti and Syrjänen: it remains dedicated to “the integration of new tools and technologies with existing people, materials and tools” (2004, 21) long after the tools—or, more precisely in the case of roads, materials—introduced have ceased to be new. Yet the approach in terms of ontological politics adds an extra layer to this notion of ongoing infrastructuring. Karasti and Syrjänen mentioned the question of “the nature-technology relationship”, and the interest to study infrastructuring processes “in the messy, uncontrollable real world settings, far away from the typical enclosed sites of professional technology development” (2004, 29). As maintenance work consistently enacts diagnoses regarding infrastructural relationships, it can be understood as infrastructuring in the sense of defining and distinguishing what is an infrastructure to what; what can be damaged for the sake of what; what systems and life forms normally interfere or should not interfere in these ecologies.

Road maintenance thus appears as “boundary-work” (Gieryn 1983), the notion having previously been applied to urban systems (Monstadt and Coutard 2019): it deals with

situations in which sectoral management comes short or requires substantial coordination work, because almost no maintenance operation affects roads without affecting trees, street furniture, underground networks... Road maintenance is particularly dedicated to holding back some specific matter that could be called natural, such as snow, rainwater, or vegetal parts. As mentioned earlier, even tree pruning consists of removing branches to give way to sunlight, which is in turn an ally for removing water. This description should be contrasted with that of the “multispecies infrastructure” studied by Morita (2017): in the Chao Phraya Delta, in Thailand, a certain rice variety, more traditional and requiring closer attention and care from farmers, proved to make water management more efficient for flood prevention. This culture was then encouraged, which simultaneously inflected an agricultural policy and an infrastructural one. Engineers designing flood management infrastructure gave room to the careful relationship between farmers and rice. This relation between different living species, and its legitimation, which account for the phrase “multispecies infrastructure”, resulted in a new way of managing the territory. This territorial question, addressed through terms such as “land” (Despret and Meuret 2016) or “country” (Rose 2013) plays an important role in multispecies studies. The case studied by Morita exemplifies a mode of infrastructuring such territories by negotiating with multiple species. By contrast, infrastructures such as modern roads, made of standardised materials that maintenance strives to protect from animal, vegetal, or other agencies, materialise a strict boundary with a whole domain that can then be called nature. Road maintenance investigated here thus appears as part of a particular, modern mode of infrastructuring, modern in that it is dedicated to preserving the boundary between nature and infrastructure. *In this view, infrastructure maintenance does not only re-negotiate local choices regarding specific urban policies, but also reproduces a more general understanding of the urban space as a discrete battlefield between ordering work and the assaults of nature.* What is usually considered “nature” is formed by elements that are actively kept apart from infrastructure by maintainers, who act as border guards to preserve the integrity of infrastructure.

The boundary between technology and environment as analytical categories has long been disqualified as “illusory” (Reuss and Cutcliffe 2010). Carse (2012) has demonstrated how nature is managed and made infrastructure. Plumwood (1991; 2009) has highlighted how the human/nature dualism, distinctive of rationalist Western thought, implies treating nature as a resource; since then, much research has shown the interest to study the work put in turning certain natural elements into resources, or “resourcification” (Hultman et al. 2021). In a similar way, investigating maintenance work enriches our understanding of how human/nature boundaries have not been solely imagined, but actively materialised through the perpetuation of infrastructures.

Conclusive Remarks

In debates on public infrastructure management, different actors—industrial companies in their lobbying effort, technicians who negotiate with elected representatives in local communities—strive to explain the complex technical problems linked to the ageing of urban networks. Their arguments lead to thickening the ontology of infrastructures: these appear as interfaces embedded in ever more complex urban ecosystems. While this complexification questions sectoral boundaries, maintenance work intervenes as a situated ordering process with its daily, discrete choices; these interventions are inseparable from diagnoses that define relationships of use, damage, and interference. Infrastructure maintenance thus acts with simultaneously political and ontological consequences as boundary-work, consistently

producing urban order and a certain understanding of nature. In this way, it can be seen as a site where local public action is tied to the perpetuation of modern boundaries and binaries. As noted by Edwards (2002), a multiscalar approach to scientific and technologic modernity is needed to account for interdependencies, and move beyond the modern narrative—inscribed in certain standards—of a divide between nature and society. While infrastructures age, maintenance proves to be a fruitful empirical entry point, as an activity dedicated to tackling interdependencies and actively negotiating standards in the material environment.

Biography

Roman Solé-Pomies is a PhD candidate at the Centre for the Sociology of Innovation (Mines Paris — PSL), with a background in executive engineering and the history of science and technology. Their PhD thesis in Science and Technology Studies (STS) focuses on asset management practices in the framework of road policies, investigating small local governments in mainland France as well as national public works organisations in a pragmatist approach.

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