

What Fragility? Multiple Professional Visions in the Maintenance of French Public Roads

ROMAN SOLÉ-POMIES
MINES PARIS, PSL UNIVERSITY, I3 CNRS UMR 9217
FRANCE

Abstract

A growing body of work in STS has highlighted the ambiguousness of infrastructure maintenance, as an activity that contributes to reproducing sociomaterial order while bringing to light its very fragility. The case of local public roads in France is instructive in this respect: for about a decade, a variety of public and private actors have been raising concerns about the fragility of this abundant infrastructure, questioning the organization of knowledge production for its maintenance after the withdrawal of centralized state engineering. This article draws on a multi-sited inquiry to extract three ethnographic vignettes that suggest the coexistence of multiple knowledges in road maintenance, oriented toward contrasted forms of fragility. I analyze these knowledges as professional visions ([Goodwin 1994](#)), associated with different notions of the most relevant expertise to make infrastructures last. The coexistence of multiple visions of infrastructural fragilities thus gives rise to new uncertainties: as the case may be, these visions might either contribute to a stabilized division of labor, or challenge existing institutional frameworks. These remarks invite us to systematically question the plurality of modes of knowing that organize infrastructure maintenance, in order to further widen the analysis of the complex relationships between material and organizational fragilities.

Keywords

infrastructures; maintenance; professional visions; situated knowledges; road management

Introduction

This contribution addresses multiple, unequally acknowledged forms of knowledge in infrastructure maintenance, and the renegotiations of the collective organization of labor associated with their multiplicity. Maintenance is known for its ambiguousness as a site of knowledge production: while contributing to the perpetuation of sociomaterial order, the situated knowledges produced by maintainers are also often silenced due to their focus on material fragilities ([Edensor 2013](#); [Denis and Pontille 2015](#)). Infrastructures such as large technical systems are an interesting site to observe this problem, as they have been analyzed both from the point of view of their unruly material behaviors ([Moss 2016](#)), and of the

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To email contact Roman Solé-Pomies: roman.sole@minesparis.psl.eu.

collective efforts invested in producing information to contain this liveliness ([Denis and Florentin forthcoming](#)). At a time of growing concerns regarding the state of ageing infrastructures, several institutional actors have raised awareness regarding a crisis of expert knowledge. Building on approaches developed by Maintenance and Repair Studies (MRS), this article investigates this knowledge crisis in terms of tensions between contrasted “professional visions” ([Goodwin 1994](#)) and modes of organizing maintenance. The apprehension of the material fragilities at play in a given piece of infrastructure can vary enormously, concomitantly with the forms of knowledge developed to address them. How is this dynamic production of knowledge organized and debated throughout the life of infrastructure, as many actors constantly intervene to make it last, long before its possible collapse?

The case of French public roads points to the crucial role of local maintenance policies which, for many years, have been vividly debated by a wide variety of stakeholders. In the early 2010s, in the wake of decentralization policies, the central state withdrew its technical support to local governments in charge of the management of a very ramified road network. Since then, both private companies and central administrations have raised awareness amongst road managers about a lack of knowledge. The need for a precise assessment of the state of roads is repeatedly mentioned as a prerequisite for good management ([Routes de France 2018](#)), as non-specialized administrations purportedly tend to underestimate the maintenance needs of their infrastructures ([IDRRIM 2014](#)). Drawing on a multi-sited inquiry, I investigate the relationships between different professional visions from standardized assessment of the robustness of roads, through the ordinary monitoring of a given network, to embodied forms of knowledge developed by workers ([Henke 2000](#)) in their daily engagement with infrastructures. Tensions between professional visions appear to have implications for broader questions raised about infrastructural policies, such as public-private relationships; the place of expertise in democratic decision-making; and the relations between planning and execution in maintenance work.

The next section reviews some of the literature in MRS and infrastructure studies, highlighting how knowledge production can be an instructive entry point to the collective organization of infrastructure maintenance. I then present the research design and methods used to investigate the multiple professional visions at play in road maintenance, in the contemporary French context. Finally, I outline three forms of tensions between professional visions dealing with different forms of material fragilities, and their implications for the analysis of “the material politics of infrastructure” ([Barry 2020](#)).

Literature Review: Knowledge Production in the Face of Infrastructural Fragilities

Maintenance and the Destabilization of Infrastructural Order

In line with a legacy in ethnomethodology, maintenance and repair have been analyzed as ordinary social processes ([Denis and Pontille 2020b](#)): broadly understood as activities dedicated to making things last, they take part in the reproduction of sociomaterial order. This has been shown by analyses of the maintenance of objects playing an obvious part in coordination, such as performative writings ([Pontille 2009](#)) or software ([Cohn 2019](#)), but also more generally in domestic spaces ([Gregson et al. 2009](#)), or urban public spaces ([Denis and Pontille 2015, 2021](#)), and in juridical order ([Rabeharisoa and Paterson 2024](#)). MRS thus use a number of notions evoking non-change, such as *preservation* ([Gregson et al. 2009](#); [Edensor 2011](#); [Domínguez Rubio 2014](#); [Yurchak 2015](#); [Denis and Pontille 2017](#)), *stability/stabilization* ([Gregson et al. 2009](#); [Jones and Yarrow](#)

2013; Barnes 2017), or *authenticity* (Jones and Yarrow 2013; Domínguez Rubio 2014). At the same time, a large part of the scholarship on maintenance has consisted in problematizing the durability of things, taking their *fragility* (Domínguez Rubio 2014, 2016; Denis and Pontille 2015; Houston and Jackson 2016; Tironi and Calvillo 2016; Rest and Ripa 2019; Barry 2020) as a starting point.

These discussions on material fragilities have paid particular attention to large technical systems such as transportation infrastructures. These provide a privileged object to study the reproductive and transformative effects of “the maintenance of materiality and power” (Henke and Sims 2020). In recent years, the political implications of infrastructures have been discussed in multiple ways (for more detailed literature reviews on the topic, see Larkin 2013; Barry 2020). As infrastructures “facilitate the flow of goods, people, or ideas and allow for their exchange over space” (Larkin 2013, 328), they play a critical role in collective experiences of time and space. They have extensively been discussed as constructing the state, by materially determining relations that constitute a “state-space” (Harvey 2012) while visibly demonstrating public action (Kaika and Swyngedouw 2000). The development of roads, a canonical example of infrastructure projects, has been analyzed as shaping institutions and debates about territorial development (Guldi 2012). Infrastructure projects have been used as empirical lenses to discuss more general shifts in modes of governance, as they experiment with the relationships between central states and local governments (Dupuy and Pollard 2014), public administrations and private companies (Mains 2012), as well as other intermediaries (Guy et al. 2011). While it has been long established that the material characteristics of infrastructures exclude certain groups (Winner 1980), it has also been pointed out that, when subverted, for instance by informal and non-institutionalized uses, they play an important role in (re)constructing “infrastructural citizenship” (Lemanski 2020). As an essential support for political power, infrastructure has been used to explain inertia and also political change: Boyer (2018) has recently suggested, for instance, that the dismantlement of globalized networks that materialize the power of certain transnational firms, in favor of decentralized networks, could support an efficient shift in the face of ecological crises.

The politics of infrastructure is destabilized and made more complex, in other words, by its needed maintenance. Many parties, from State engineers to local populations, encounter conflict and ambiguity from the multitude of choices proposed for making infrastructures last; this is why Barnes emphasizes “the importance of looking at infrastructure maintenance not as a singular, unified process but as one that is highly differentiated and deeply embedded in *local understandings*” (2017, 160, emphasis added by Solé-Pomies). The essential role of maintenance and repair as sites of conflict has been highlighted in the development of infrastructure in the global South (Jackson et al. 2012). Yet, maintenance as well as repair are also a growing concern in global North configurations: the vulnerability of infrastructure is at the heart of some public policies (Lakoff and Collier 2010), being especially debated after major accidents (Henke and Sims 2020), as illustrated by the attention raised by the Morandi’s bridge collapse in Genova in 2018. As an object of collective concerns, the common hypothesis of the “obduracy” of infrastructures (Hommels 2005) appears not to be given once and for all. In this respect, the production of knowledge and information about the material behavior of infrastructures can become a topic of vivid debates (Barry 2013). More specifically, material fragilities—understood as the tendency of infrastructures to decay if not properly taken care of—are a critical concern. Road managers, for instance, worry that wear and tear results in cracks in the upper

layers of roadways, then leading to water infiltrations that destabilize the deeper structure. Knowledge of such continuous dynamics of degradation is at the heart of maintenance policies.

Professional Visions and Material Fragilities

The complex dynamics of infrastructural order are aptly captured by the notion of *material politics*. One of its central challenges is the production of knowledge in the face of material instability:

At a time when social theorists and philosophers have drawn our attention to the agency, liveliness and unruly activity of materials, we need to be aware that the existence of materials is *also* routinely traced, mapped and regulated, whether this is in order to assess their quality, safety, purity, compatibility or environmental impact . . . ([Barry 2013](#), 5, emphasis in italics added by Solé-Pomies).

MRS problematizes the relationship between these two aspects of materials by investigating contrasted forms of knowledge and the associated divisions of labor that address the activities of materials. Dealing with the liveliness and unruliness of materials—what Tim Edensor ([2011](#)) analyses as “entangled agencies”—maintenance and repair work is often improvisatory. As such, it partly escapes detailed planning. However, its careful study reveals complex organization revolving around situated forms of knowledge, as maintainers constantly investigate to identify the causes of actual or possible breakdowns ([Graham and Thrift 2007](#); [Henke 2000](#); [Orr 1996](#)). To this end, they mobilize various forms of attention in their bodily interactions with artefacts ([Dant 2010](#); [Denis and Pontille 2020a](#)). The knowledges thus produced circulate among maintainers through narratives ([Orr 1996](#); [Rosner and Ames 2014](#)).

At the same time, some works have pointed to how material fragilities are tackled by expert knowledges that have strong institutional recognition ([Chatzis 2008](#); [Ureta 2014](#); [Yurchak 2015](#); [Domínguez Rubio 2016](#)). In the case of infrastructures, their material politics are an important concern for public policies. As shown by Lakoff and Collier ([2010](#)) in their analysis of techniques of preparedness, the management of risks associated with infrastructural vulnerability constitutes a response to political demands; this is an integral part of the exercise of power by experts and officials. Similarly, Manuel Tironi and Nerea Calvillo emphasize the crucial role that knowledge tools play in negotiating with elements such as air and water, in the face of risks like tsunamis or atmospheric pollutions; materials that need to be governed “in their excessive and unwanted condition” ([2016, 208](#)). Infrastructure policies can thus lend insight into the broader question of cosmopolitics.

The contrast between these forms of expertise calls for an elucidation of the institutional organization of knowledge production concerned with infrastructural fragilities. The multiple and distributed character of modes of governing that emerge from practices dedicated to monitoring materials leads to specific institutional arrangements ([Bulkeley et al. 2007](#)).

The variety of modes of knowing for dealing with a diversity of material objects has long been addressed by infrastructure managers themselves. Take the example of the Minneapolis bridge, whose collapse and its consequences are recounted by Henke and Sims: while after the collapse, “additional repair concerns emerged,” ([2020, 7](#)) a variety of such concerns had emerged long before the event, throughout the life of the bridge:

First, in 1977, they [the Minnesota Department of Transportation] increased the thickness of the concrete on the bridge deck to protect against corrosion due to road deicing chemicals. By 1998, the median barrier and railings on top of the bridge no longer met current safety standards, so these were removed and replaced. At the same time, a computer-controlled anti-icing system was added to address the large number of winter accidents on the bridge. In 2007, contractors were in the process of grinding down and replacing the aging concrete of the bridge deck when the bridge collapsed. ([2020, 6](#))

Documentary and embodied forms of knowledge in maintenance have been analyzed as diagnosis ([Orr 1996](#); [Graham and Thrift 2007](#); [Sanne 2010](#); [Jackson et al. 2012](#); [Rosner and Ames 2014](#); [Denis and Pontille 2015](#); [Callén and Sánchez Criado 2015](#)). The MRS literature has also regularly, though sometimes in a fairly allusive way, resorted to the vocabulary of testing ([Orr 1996](#); [Yurchak 2015](#); [Domínguez Rubio 2016](#); [Denis 2018](#); [Cohn 2019](#); [Denis and Pontille 2021](#)). Diagnoses put to the test not only material fragilities, but also fragilities in sociotechnical relations, as conveyed by Blanca Callén and Tomás Sánchez Criado's notion of *vulnerability tests* ([2015](#)). How, then, do different kinds of documents and bodily engagements address these different forms of fragility? When is this division of labor itself put to the test? The question of different forms of knowledge produced in unruly material environments, or “complex perceptual fields” ([Goodwin 1994](#)) is precisely what Goodwin's notion of *professional vision* addresses, while questioning the delineation of professional groups.

Professional vision “consists of socially organized ways of seeing and understanding events that are answerable to the distinctive interests of a particular social group” ([Goodwin 1994, 606](#)). It relies on *coding schemes*—“one systematic practice used to transform the world into the categories and events that are relevant to the work of the profession” ([ibid., 608](#))—that jointly produce a collective organization and the relevant features of the things to be known. In this embodied approach to the organization of collective work through visualization, “some traditional dichotomies that have isolated subfields from each other, such as the assignment of language and the material world to separate domains of inquiry, disappear” ([ibid., 626](#)). As it tackles the formation of distinctive forms of knowledge, I suggest that the vocabulary of professional visions helps account for a division of expert labor in infrastructure maintenance, but also how experts reflexively question who has the ability to diagnose the most critical forms of material fragility. To support this argument, I have engaged in an investigation focused on a variety of situations in which the relevant expertise on infrastructural fragilities is debated, putting to the test the collective organization of maintenance work.

Empirical Material and Method: Tracing Professional Visions in Road Maintenance

The case of French public roads is illustrative of monitoring and assessment efforts dedicated to informing infrastructural policies, and of a complex institutional organization of maintenance. It illustrates how the joint problematization of infrastructural fragilities and state expertise translates into an effort of coordination among a variety of actors, through the aggregation of data across time and space. For more than a century, the execution of roadworks in France has been largely delegated to private companies, who have developed and structured their industry in the form of business associations, posited as partners for public infrastructure managers ([Barjot 2006](#)).

Over the past two decades, however, road management has been increasingly decentralized. A growing concern has then emerged, both in central administrations and in roadworks business associations, about the lack of centralized knowledge: the state of roads, but also management practices in local communities, have been poorly known ([Rapoport et al. 2017](#)). These debates have led to efforts for restoring expert knowledge—from the creation of a national observatory in charge of investigating local road policies through a yearly survey ([AdCF et al. 2015](#); [IDRRIM 2021](#)) that was recently discussed as possibly insufficient, since it does not mandatorily request standardized data from all local governments ([Cour des Comptes 2022](#))—to a specific program dedicated to the safety of bridges ([Cerema 2020](#)). Business associations of roadworks companies advocate for an approach to roads as a “*patrimoine*” ([IDRRIM 2016](#))—a French term that can both be rendered as “heritage” and “asset,” that conveys the sense of a need for an active effort of knowledge and preservation for future profits. These business associations have contributed to the production of technical guides addressed to local governments, especially concerning road diagnosis ([IDRRIM 2022](#)).

Given that debates concerning road maintenance bring together organizations that intervene in very different spatial perimeters, such as different scales of local governments, central state administrations, local, national, and transnational roadworks companies, or research institutions, their analysis benefits from multi-sited investigation, as extensively discussed by Antti Silvast and Mikko J. Virtanen ([2019](#)). I have studied the management of local public roads in mainland France for three years. My inquiry started in a national business association of roadworks companies, whose communication efforts advocate for preventive methods in road management. At the beginning of my research, two engineers from its staff gave me a brief training into these technical issues. The word “diagnosis” was ubiquitous and designated the ability to read into roads’ symptoms: the various cracks or distortions indicated different “pathologies,” for example. They operated as traces in the sense that Ginzburg notably associates with clinical practice ([1989](#)): discrete signs that are discriminant in that they are insignificant to many, and meaningful only to skilled observers (sometimes, in the case of roads, equipped with sophisticated instruments). The specific forms of attention emerging in this training, supported by a number of technical guides, participate in delineating the professional vision of technicians—hence the necessity to study documents as sites of articulation of coding schemes and graphic representations ([Goodwin 1994](#)).

Throughout my research, I strived to trace the problematizations of expertise in national instances. I started with a research project dedicated to the “Lifespan of roadways,” in the framework of which I was able to attend the report-out session. I observed that the business association strived to cooperate with local governments as often as possible; the role of research in a problematization of expertise that was expected to bring together public and private organizations will be the object of subsection “Measurement as an Interface.” I then attended a number of events dedicated to these encounters with road managers, from national conferences on the new roadworks techniques to smaller-scale meetings organized by the association, with a few local elected representatives selected in local governments where they had connections. IDRRIM (Institut des routes, des rues et des infrastructures pour la mobilité—Institute for roads, streets, and mobility infrastructures), the institute in charge of the national road observatory, also appeared as a privileged space for public-private collaborations, as it was intended to replace certain former state services, and is jointly operated by public authorities and business associations in the roadworks

industry. From October 2021 to April 2023, I attended the five meetings of the board in charge of supervising the observatory, which gathered representatives of these different institutions; this informed my understanding of the problematization of diagnosis in local governments, further discussed in subsection “Supervision across Time and Space.” In total, I observed 18 events in such national instances. To further document these different projects, I have maintained regular informal exchanges at the business association and the IDRRIM, reviewed their documentary production, and conducted 19 formal semi-directive interviews with the different institutional stakeholders.

My understanding of the problematization of relationships with local governments at the business association was widened by 21 meetings dedicated to the joint design of an inquiry into small local governments. I investigated fifteen local governments, several of them being suggested by the business association for their territorial or institutional specificities. Having already noticed the multiple problematizations of expertise at play, I strived to further diversify the sites of investigation. I specifically focused on a local community with fairly different features from those brought to my attention by roadworks companies: it was a vast federation of municipalities with no shared management model and contrasted sub-territories, with some municipalities enjoying substantial resources and others being much more isolated with more constrained budgets. I finally spent four days there observing workers and accompanying them in their daily tasks; this brief ethnographical glimpse helped approach the results of the rest of the inquiry with caution, as will be discussed in subsection “Sweeping Delegated and the Limits of Professional Visions.” In total, I conducted 60 interviews in local governments, complemented by 10 half-days spent observing maintenance work or local meetings.

I thus traced various framings of the political problem of how to make local road networks last. Debates about the relevant policies for public road management lead the actors to confront different forms of knowledge, focusing on different fragilities within the same infrastructure. They question the institutional distribution of responsibilities by discussing what kinds of material fragility should matter in a given situation.

Analysis: Knowledge Production in Road Maintenance Policies

The following analysis builds on three vignettes that illustrate tensions between contrasted professional visions within the complex collective organization of road maintenance. The knowledges produced do not grasp the same material fragilities, from research programs dedicated to addressing the ageing of roadways on a general agenda, through the organization of long-term management in a given local government, to the execution of daily maintenance tasks.

Measurement as an Interface

How do roadwork companies problematize maintenance? In 2016, their associations initiated a national research project called “Lifespan of Roadways.” This five-year, 4.5 million euro project brought together public road managers, research organizations, and roadworks companies themselves. As its title indicates, participants strived to inform the central concern of maintenance policies, that of making things last. Their stated aim was to contribute to the organization of maintenance on a national level: investigating the material fragilities of infrastructure was also a way to highlight the institutional fragilities associated with

the withdrawal of state engineering. As explained to me by the scientific director of the public-private institute in charge of the project, during an informal conversation on the day of a meeting on the ongoing research,

There is also a change of worlds, clearly linked to the decentralization and the removal of the DDEs [Directions Départementales de l'Équipement, former state services in charge of providing technical support to local road managers] about 15 years ago. So, there used to be a world that had objectified a very clear technical doctrine with the technical means of the time . . . And now there is nothing, or we don't know anymore . . . And then there are new people who are much more relevant and bring new technology . . . The whole purpose of the project will be to bring this world to build something that goes forward . . . This is one of the concerns, this issue of measurement of the indicator of durability of the roadway. (field notes by Solé-Pomies, January 2020)

In other words, the project aimed at re-building a community of concern by scientific means. Concretely, one of the most recurrently raised issue is the relative distrust of local governments with regard to the services of private companies. One of the goals of such research partnerships in civil engineering is to address this through shared standards that apply everywhere: for instance, several sub-projects identified categories of roads, depending on their traffic, their good state, and their construction techniques, and were then based on partnerships with road managers to conduct experiments on certain roads within these categories, in order to produce reproducible results. The importance of the reproducibility of scientific results, for building this community of concern, was particularly well illustrated by meetings during which the results were presented to an audience gathering representatives of research institutes, road companies, and local governments. In 2020, at the beginning of my investigation, I was able to attend such a report-out session. In order to emphasize their contribution, researchers explicitly contrasted their production with preexisting forms of knowledge. In one instance, it came to the point that a researcher presented what resembled an ethnographic vignette.

The research team was presenting its work on developing a measuring tool for assessing the robustness of road interfaces. When a new roadway is constructed using several tarmac layers, those are generally bonded with a bituminous emulsion; the quality of this bonding must then be controlled. One of the first slides displayed a picture of a man in a yellow vest, kneeling on a road and apparently sticking his screwdriver into a circular groove at the surface of the road. As the presenter explained, this was an illustration of “the screwdriver test”: in this method, a cylinder is cut in the upper layer, a worker sticks their screwdriver in the groove and uses it as a lever to feel if they can detach the cylinder. Being quick and inexpensive, the screwdriver test was said to be the most common method to check the quality of interfaces between road layers. According to the researcher, however, it is not satisfactory due to five properties:

- The effort applied by the worker models a traction and not a torsion, road layers being usually subject to the latter
- The results depend on the musculature and sensitivity of the worker
- The temperature of the interface, an important parameter, remains unmeasured
- The test does not produce any quantitative measurement

- Consequently, no common quantitative criterion exists for assessing conformity.

The tool developed by the research team was then presented as a remedy for all these shortcomings. It cuts a cylinder in the upper layer of the new road, applies a torsion to it and measures the resistance. It thus assesses the behavior of the road when exposed to shear stress at the interface between layers. It also measures the temperature of the interface. The prototype was tested in the lab, then in the field, before being modelled. The conclusions were that this measurement process has several advantages: it is quick, relatively cheap, semi-destructive (the damages inflicted to the road being easily fixed). Most of all, it is said to be both practical and reliable, in the sense that it provides a measurement comparable to a criterion commonly shared across the industry.

This presentation of the new measuring tool introduced a clear competition between two coding schemes. It disqualified the screwdriver test, mostly on the ground of its lack of repeatability—conceptualized through the relative roles of bodies and numbers. As highlighted by the researchers, the screwdriver test locates diagnosis in the arm of the worker performing it. It consists of a reversible, mechanical interaction between the object to be known and the knowing body—reversibility being a distinctive trait of touch “aka proximal intimate knowing” ([Puig de la Bellacasa 2017, 20 and 112–22](#)). The simplicity of the screwdriver maximizes this reversibility: it operates as a minimal mediation that situates the worker’s body within the symmetrical relation between the effort applied and the resistance encountered, relying on habits inscribed in nerves and muscles. By contrast, the new instrument is expected to give the same result to anyone because it puts the knowing body at a distance, replacing it with an object of standardized behavior. This resort to quantification and a standardized instrument, mediating a mostly visual rather than mechanical relation with the working body, evokes a search for “mechanical objectivity” ([Daston and Galison \[2007\] 2010](#)), its crucial challenge being to eliminate the specificities of the experimenter. In other words, a distinctive trait of this professional vision is that it achieves reliable assessment by avoiding the superimposition of the unruliness of working human bodies and the unruliness of materials.

The new coding scheme provides a normalized, quantified measurement that can circulate in written reports. The presentation operated as a test of such circulations, displaying different graphs showing relations between the different quantities measured—temperature, constraint, and rotation. In contrast with the screwdriver test, the slides insisted on the monitorability of all relevant parameters, thus “enabling a mathematical relation.” The receptivity of the audience was also tested. While the theme of the meeting and research program was the lifespan of roadways, the relationship of this new instrument to maintenance is not obvious: on the contrary, the prototype is designed to assess a form of robustness literally intrinsic to roads, independently from maintenance efforts. Maintenance is yet an important concern among road managers, who were largely represented in the audience, and whose work was directly addressed, and even investigated, in other presentations. This presentation was warmly welcomed when the researcher asked companies and road managers about their interest and the price they would find acceptable for such an instrument. The concern for a standard compliance criterion, in particular, plays a part in consolidating the distribution of responsibilities between the road’s constructors, who have to deliver a road with robust interfaces, and its managers, who do not want to question this conformity once it has been assessed.

Quantifying the robustness of a material interface within a roadway contributes to strengthening the organizational interface between the company delivering this piece of infrastructure and the public authority in charge of its future maintenance.

Putting to the test the fragility of a material interface within a new roadway locates the issue of durability in the road as it is, not in its long-term maintenance and use: it is supposed to anticipate whether the interface will resist the later traffic of heavy vehicles. The purpose of this coding scheme is to provide a more robust assessment of the quality of newly delivered roads, in order to demonstrate that the roadworks outsourced to the company have been executed properly. In this way, it is expected to consolidate the contract, on which doubt could otherwise be cast by the lack of technical expertise of public authorities, itself a consequence of the withdrawal of state engineering. Mechanical objectivity is thus relied on to problematize jointly a particular material fragility and a particular organizational fragility. One cannot predict whether and to what extent the use of the new instrument will spread out but can observe that the new coding scheme was approved by its audience. In other words, a professional vision that trusted academic research and numbers was succeeding against the one constructed as its rival (the screwdriver test), precisely because it had demonstrated its ability to connect a material fragility and an organizational one. Considering that this innovation intervenes in a critical moment—the completion of a new or newly refurbished roadway—it only delineates the external boundaries of maintenance work and tells little about the problematization of expertise in the ongoing work of road managers.

Supervision across Time and Space

In debates about decentralized road policies, a recurrent concern has been expressed by central administrations ([Rapoport et al. 2017](#)), associations of roadworks companies ([Routes de France 2018](#)), and their joint public-private organizations ([IDRRIM 2021, 2022](#)), namely the ability of any local government to equip itself with a synoptic diagnosis of its road network. While this concern has been used as an argument for the restoration of centralized supervision on a national level ([Cour des Comptes 2022](#)), it is also raised by technicians in local governments that make do with decentralization policies, striving to renew their organizational solutions. For instance, in a rural territory comprising 500 municipalities organized in 20 federations, local governments operate a shared agency whose purpose is to provide technical support to small administrations, even though it has only taken up a very limited part of the missions of the former state services. According to the person in charge of roads, one of the main requests he gets from local governments is the production of diagnoses. What role do such diagnoses play in decentralized governments? They are systematically expected to address the tension between the priorities of technicians and those of locally-elected representatives. Diagnoses are often expected to demonstrate which roads should be made a priority, and to justify maintenance budgets. One of the most often mentioned goals of the

national road observatory,¹ which encourages local governments to systematically diagnose their roads, is to help technicians prove that roads require a certain level of investment in their territory. The roadworks industry as well as central administrations thus discuss this tension between the priorities of elected representatives and technically-skilled staff as another form of institutional fragility, that can be partly tackled through diagnosis.

At an early stage of my inquiry, I met with the head of the technical departments in a federation of 21 municipalities, which had been cited to me as a good example of mutualized management; he showed me a clear example of synoptic diagnosis in the form of a document with strong organizational implications. The director first recounted a shift in the road management model that occurred a few years earlier, in 2016. Technical staff for local public roads had been mutualized for years at the scale of the federation; however, the overall budget used to be redistributed to municipalities. The prioritization of roadworks then remained in the hands of locally-elected representatives at the municipal level. Around 2015, the federation of mayors decided to install the head of their common technical departments as the head manager of roadworks. He then decided to have an overall “diagnosis”² (in his words) of the road network made by a consulting company. This initiative and the resulting document were to him a crucial tool to shift from the previous management model to a new one, in which prioritization should result from “objective choices made by technicians.” [Figure 1](#) reproduces an excerpt of the updated diagnosis. It takes the form of a spreadsheet in which each row gathers information regarding a given street. The first two columns provide general information relevant to the structure of the network (i.e. name and length of the street). The following two columns gather observations in the form of comments stemming from visual inspections, completed by references to photographs. Then comes a threefold, color-coded column translating the previous observations into a single indicator for the state of the street: red stands for emergency; in orange, some work would be required; green does not request immediate attention. While these first columns can be read as the diagnosis strictly speaking, the clinical metaphor could be extended to describe the next four columns, which recommend appropriate treatments. The very last part records roadworks that have effectively been conducted, in a form that somewhat echoes a medical report.

¹During all the five meetings of the supervising committee of the observatory organized between October 2021 and April 2023, this was systematically discussed as the most relevant argument to motivate local governments to provide data.

²This and all other elements from the head of technical departments mentioned in this subsection, as well as the document reproduced below, come from a semi-directive interview conducted with him in February 2020.

Street	Length (m)	Observations	Pictures	STATE			Recommendations	Quantities (surface area, length...)	U	Global Estimation per street in € excluding taxes	Work realized € excluding taxes
				Emergency: Street in a very bad state	Some work to preserve the roadway	New street or in a very good state					
Pillory Street	365	Pathway with no border or sidewalk between School Street and the Church	1							25 250,00 €	implementation of asphalt concrete, company X, total of work: 24 172,80 €
		Surfaced pathway over 104m									
		Satisfactory structure but surface completely damaged	2 to 6				Scarification of existing form, re-profiling with gravel and concrete over 0,05m	650	m ²		
		Then stone pathway until the Church over 110m	6 to 9			2017					
		Between School Street and Main Street: Street with border on both sides but no sidewalk	9 to 13								
		Some potholes	12				Bitumen emulsion and gravel on potholes	5	m ²		
Bud Path	142	Pathway with no border or sidewalk. Satisfactory structure but surface with networked cracks in places	1 to 6				General chipsealing	450	m ²	3 118,50 €	
Strawberry Street	104	Street with no border or sidewalk. Satisfactory structure but surface with networked cracks	1 to 5			2019	General chipsealing	350	m ²	2 425,50 €	chipsealing, company Y, total of work: 3466,99 €
School Street	106	Pathway with no border or sidewalk. Between Pillory Street and the town hall: Satisfactory structure, recent cold-mix asphalt concrete	1; 2								
		Then, over 24m: satisfactory structure but surface worn out	3; 4								
		Then until Vale Street: recent asphalt concrete	5; 6					General chipsealing	80	m ²	554,40 €

Figure 1. Excerpt (resized) of an updated diagnosis of roads in a federation of municipalities (early 2020). All columns are represented, except for the first one that specifies the name of the municipality. Translated from French by the author; the street names were changed, and the companies were anonymized (Source Solé-Pomies).

The table operates as a graphic representation of the technician’s concern for regularity over time and space: according to him, what is critical is the structure of the diagnosis—two features, more specifically. First, he insisted that the spreadsheet would have been useless if it had not been possible to update it regularly. The three colors refer to the idea of a temporal cycle of decay and refurbishment, in any particular roadway. As the roadway ages, its state goes from green to orange, then red. When it is refurbished, it comes back to green, which is indicated by an arrow with a date in the table. But more importantly, through the structure of rows and columns, as well as the color code and quantified budgetary data, mundane commensuration techniques enable the comparison between all road sections within the same visual space. The diagnosis is meant to be synoptic both in time and space. It provides a particular way to grasp the problem of prioritization, based on the technician’s careful supervision rather than elected officials’ responses to varying demands. Only a limited amount of money is allocated to refurbishment. If, for some years, certain strategic road sections are systematically favored, being refurbished as soon as they go orange—which is the alleged tendency of elected officials—then in the meantime all other sections will go red, and the overall state of the network will decay. If, on the contrary, priority is systematically granted to roads in the poorest state, then it is theoretically possible to gradually reach a stage when almost no section is red. Ultimately,

the whole network should remain in a rather good state. The table makes this problem clear by constructing a visual knowledge of the network, not as a series of independent road sections, but as a whole that should be maintained as regularly as possible.

As such, the document can be concretely used to inflect the maintenance policy: every year, in a roadworks commission involving elected representative, the table enables the technician to negotiate the allocation of funds to certain roads rather than others. As the spreadsheet emphasizes the relative emergency of certain roadworks, comparing it to their relative costs, priorities are primarily determined by the state of the roads in relation with available funds. This, however, does not eradicate other modes of reasoning. Shortly after the introduction of this new management model, new municipalities were included in the federation. Due to a lack of financial resources, their roads had been neglected and were in a poor state. When these roads were integrated into the spreadsheet, their refurbishment should have been a priority because they were those in the poorest state. However, due to the limited investment capacity of the federation, this would have implied that all funds were allocated to them for at least a few years. Mayors from the former municipalities argued that it would be unfair to neglect their roads, which would decay in the meantime, while they had long been taking good care of them. In our interview, the head of technical departments reported this argument as a serious one, which justified a compromise between the two modes of reasoning. For a few years, part of the budgets would be allocated to refurbish the newly managed roadways, while another part would be kept to perpetuate the refurbishment cycle already initiated in the rest of the federation. The diagnosis had thus reframed local debates on road maintenance, as the documentary knowledge produced became a critical site of political decision-making about the state of roads and local maintenance policy.

Unlike the preceding measuring instrument, the diagnosis table does not deal with the material fragility of a particular point in a particular road: instead, it addresses the state of a road network as a whole. More strikingly, the kind of data gathered does not include the kind of measurements produced by the aforementioned instrument: when a particular roadworks operation is recorded in the history, no comments on the quality of the work done by the roadworks company is written in the table. The history is limited to information about the decisions of which the federation's technical department is in direct control (the choice of the materials, of the company, the price they agreed to pay). This is because the purpose of the table is not to produce an agreement on the quality of the work done when a new road is delivered. Instead, the diagnosis contributes to the assessment of the long-term maintenance policy implemented within the local government. In doing so, its coding scheme ties the material fragility of the road network to a particular institutional fragility, that of the distribution of responsibilities at play in the federation of municipalities. This leads to another form of relationship between alternative professional visions. The form of knowledge produced by the measurement tool was supposed to replace previous coding schemes by intervening on critical points in space and time; the diagnosis table is intended to operate on a much more general level. The flipside of the coin is that this table does not claim to rule out other forms of attention to material and institutional fragilities: the professional vision of the technician acknowledges the need to constantly negotiate with elected representatives who bring other notions of institutional responsibilities. This suggests that the form of expert knowledge needed for monitoring infrastructure is not stabilized once and for all, together with a collective organization delineating its jurisdiction. Rather, in the face of ageing

materials and evolving institutional forms, new concerns emerge from ongoing maintenance efforts, giving way to re-negotiations of the relevant professional visions.

Sweeping Delegated and the Limits of Professional Visions

Does this mean that the institutional organization of delegation and discipline is completely open to renegotiation ([Star 1991](#))? Should we hope that, as the issue of infrastructure maintenance raises, all relevant knowledge will soon be translated into a variety of tables and documents, brought to a table of negotiation welcoming to any possible concerns related to infrastructural fragilities? The situations depicted so far do not appear particularly revolutionary. While they illustrate the transformative potential of collective efforts to tackle material and institutional fragilities, they give no reason to believe that the foundational questions of MRS regarding the division of labor have found their ultimate answer. The ethnographic vignette I will now present is derived from the observation of some daily tasks of maintenance workers. While it does not account for the complexity of hierarchical relations in the organization of road maintenance, it helps highlight how the vocabulary of professional visions should not overlook this political issue, but rather include it in the analysis of how material and institutional fragilities are problematized in different arenas.

In one of the sites of my investigation, I followed Jojo,³ the driver of a street sweeper, in his daily patrol. He took me onboard, insisting that his manager should do the same, because Jojo was about to show me things that neither I, nor his boss, were probably aware of. During the first part of the tour, as he was patiently dealing with the various forms of litter scattered across the streets, he drew my attention to the discomfort caused by the jolting of the vehicle, clearly due to poor shock absorbers that amplified even small irregularities in the road surface. We finally left the town center to enter a peripheral, residential neighborhood. I had explored it on foot: according to the head of technical departments' explanations, it was the area in which streets had been most recently refurbished, which was clear from the absence of any visible crack in the roadway. As we were approaching, I thus expected that the ride onboard the street sweeper would become easier. To my surprise, the jolting markedly increased. Jojo explained to me that the road had been poorly renovated: it was not planar, which was not necessarily perceptible in other vehicles. He had reported this defect to the director, but he thought that nothing would be done. There was more: I had spent the morning watching him maneuver a swivel arm attached in front of the vehicle, equipped at the end with a big rotating brush. He pointed out that in this new street, the gutter had been poorly made: it was both too narrow and too deep, making it difficult, if not impossible in some places, to clean it properly using this arm. Jojo's observations about the new streets were not documented: he does not write any daily report. His observations are mostly transmitted orally to his manager.

Interestingly, defects in the planeness of roadways are classically problematized by civil engineers. Yet, according to Jojo, such defects did not raise more concern in the head of technical departments than the geometry of the gutter. This can be easily understood if one asks where material fragility is located. The

³ The nickname was changed for anonymity.

sweeper, with its old shock absorbers that amplify irregularities in the ground, could be said to operate as a testing device for the quality of road surfaces. Or, conversely, it could be said that the road, being slightly irregular, puts to the test the shock absorbers of the sweeper. All in all, as both Jojo and I could feel, their material encounter was problematic—but to whom? As civil engineers actively study the planeness of roads, it would be no surprise to them that a street refurbished by a local company in a small local community is not very plane, none of the organizations involved having the resources or need for sophisticated testing of such qualities; and no one in the technical department of the town would be surprised to learn that this old sweeper, which has to be used when the more recent one is undergoing repair, is uncomfortable even on very slightly bumpy streets.

Observations regarding both the planeness of the street and the geometry of the gutter emerged as Jojo encountered practical difficulties in his work, and they remained confined at the end of long chains of delegations. To enjoy dry roads that are not too soon damaged by infiltrations, the evacuation of rainwater is delegated to the gutter; the efficiency of the gutter depends on its cleanliness, which is in turn delegated to a worker with their machine; only in the interaction between the machine and the gutter does a geometrical problem emerge, which is dealt with in an improvisatory way by the driver themselves. Similarly, the cleanliness of streets is directly delegated to the sweeper; its operation is delegated to the driver, whose comfort is delegated to shock absorbers; if these are too old to soften the undulations of the roadways, only the driver suffers from this incompatibility. Other users have better shock absorbers, or do not circulate this residential street for too long.

Jojo's observations arguably stem from a coding scheme, as the systematic process of sweeping fosters attention to specific features of his material environment. However, they do not give way to graphic representations, demonstrations, or teaching, which play a crucial role in professional visions ([Goodwin 1994](#)).⁴ They rather constitute an embodied, highly situated form of knowledge, emerging from problematic situations experienced by the worker alone. As such, there is no point in considering them for the head of technical departments. In his concern with the cycle of refurbishment of the network, the quality of a new road is not to be questioned so early. Even though he expresses awareness of the working conditions of his staff, especially moments of fatigue, the mundane problems of daily upkeep are delegated to his workers.

The relationships of delegation at play in the collective organization of maintenance thus distribute different problematizations of the temporality of infrastructures. Maintenance workers in local communities reiterate their bodily engagement with machines and roadways on a daily basis, in order to address any problem that might occur. To them, the state of roads is potentially problematic at any moment. In contrast, synoptic diagnoses rely on well-delineated operations of refurbishment, which result in new roads that will not need any major intervention for at least a few years. It is precisely with the argument of reinforcing this delineation, and the reliability of heavy work, that certain techniques of assessment are

⁴ Our moment of observation carved out a very modest exception, explicitly seized by Jojo as an opportunity for demonstrating his knowledge.

developed to guarantee the compliance with standards, thus ensuring that the work of a construction company is over. In other words, the various forms of knowledge analyzed here are associated to a division of labor characterized by temporalities of “taken-for-grantedness” ([Star and Ruhleder 1996, 113](#)). Once maintenance is questioned, infrastructures cannot be collectively taken for granted indefinitely anymore. However, once they have proved the robustness of their roads, companies can ignore maintenance issues; once they have refurbished a street, technicians need to rely on its good state for a few years in order to organize their planning; maintenance workers, by contrast, can never take the good state of infrastructures for granted. This ecology of delegation entails the not always peaceful coexistence of interdependent modes of knowing ([Star and Strauss 1999](#); see also [Haraway 1988](#)), some oriented to objective demonstration in critical moments, some characterized by a professional vision supposed to organize the long-term management of infrastructures and enroll officials, while others can remain silent.

Institutional efforts dedicated to the development of expert knowledge on the ageing of infrastructure in the long term should not suggest that protocols can ensure control over all material and institutional fragilities ([Barry 2013](#); [Henke and Sims 2020](#)). The strengthening of mechanical objectivity or synoptic visions in the pursuit of quantitative assessment is known to both discipline and disqualify more improvisatory, embodied forms of knowledge to which certain fragilities are delegated so they can be overlooked in other institutional instances. What the driver of a street sweeper experiences on a daily basis is less the fragility of the roadway itself than that of the interaction of sweeping, in which material fragilities located in the road, in the machine, and in the working human body confront each other. As long as they do not produce graphic representations to pose this as a problem for the organization with other workers, that is, as long as neither a *profession* nor a *vision* strictly speaking comes to existence to address these material fragilities, these fragilities do not question the institution, but remain a problem only for workers themselves. In such instances, combining the experience of workers with the coding schemes of ethnographic observation might contribute to the emergence of a vision able to question existing divisions of labor.

These divisions can be reproduced indeed by institutional policies more aware of infrastructural fragilities. Shared concerns for infrastructure maintenance may translate into multiple forms of knowledge that do not always peacefully coexist: the (re)structuration of a centralized expertise that develops new methods to monitor material fragilities, instruments for the negotiation of local policies that are shaped by specific institutional configurations, and embodied knowledges that are uneasily restituted due to the very division of labor that frames them.

Conclusion

Following Tironi and Calvillo’s ([2016](#)) invitation, the multi-sited inquiry into the collective organization of infrastructure maintenance reveals a multiplicity of *modes of knowing*—which have been theorized elsewhere as questioning together “architectural and spatial arrangements, institutional forms, economic structures, modes of circulation, and life courses for knowing subjects” ([Law 2016, 43](#)). Approaching them more specifically in terms of professional visions shows how the distribution of attention to different material fragilities goes hand in hand with the renegotiation of institutional responsibilities. Through the investigation of this collective organization of knowledge production, the tension between the unruliness of

materials and efforts of monitoring that is characteristic of infrastructure appears as a reflexive subject of debates among actors of public policies. The long-term production of knowledge about material fragilities is made into a public concern, raised not necessarily by innovation or even the breakdown of infrastructure, but rather by maintenance strictly speaking, that is, the ongoing work of making fragile things last.

While multiple modes of knowing participate in making infrastructure networks last, they offer different problematizations of their material durability. Maintenance studies bring a particular contribution to this approach, as they move beyond traditional focus on construction, breakdown, or other critical events and associated controversies, to investigate mundane routines ([Graham 2010](#)). With this in mind, the investigation into the various parts of the collective management of infrastructures reveals different, unequally visible forms of knowledge. Increased attention to infrastructure maintenance in the public agenda leads to the production of new forms of stabilized knowledge about specific material fragilities. At the same time, distinctive forms of expertise that leverage spatial and temporal factors emerge as negotiation tools within the deployment of management policies, in institutions more aware of the ageing of infrastructures. These often standardized knowledges are in tension with other forms of knowledge, which are less easily circulated and, by extension, less easily codified into professional visions. The rise of a general concern for maintenance in infrastructure policies can intensify this tension, perpetuating the invisibility of certain knowledges, such as those dedicated to daily maintenance tasks.

This ecology of knowledges depends on how the temporality of infrastructure is taken for granted in a given situation. The study of the material politics of infrastructure strives to explain the endurance of large systems in relation with the “second-order infrastructures of knowledge production” dedicated to monitoring their material transformations ([Barry 2020, 104](#)). Here I have highlighted a specific question that could be systematically addressed in this framework: what fragilities does any particular form of knowledge about infrastructure address and neglect, and how is this framed by specific institutional forms? Developing a measuring instrument to quantify the robustness of roadway interfaces makes construction companies accountable at a given point in time, delegating ulterior maintenance to road managers. Implementing a centralized tool for supervision in a local administration makes longer-term fragilities visible. However, certain material frictions still escape institutional visions as both their knowledge and confrontation are delegated to workers—such as a dysfunctional gutter that obliges a sweeper to spend a long time travelling on a deformed pavement, in an old vehicle that hurts their back.

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Author Biography

Roman Solé-Pomies is a postdoctoral researcher who recently completed a PhD at the Center for the Sociology of Innovation, Mines Paris - PSL, Paris, France, with research interests in the collective organization of infrastructure maintenance and the underlying conceptions of the environment.

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⁵ ADF (Assemblée des départements de France—Association of French departments), Ministère de l'Écologie, du Développement durable et de l'Énergie (Ministry of ecology, sustainable development, and energy), IDRRIM (Institut des routes, des rues et des infrastructures pour la mobilité—Institute for roads, streets, and mobility infrastructures), USIRF (Union des syndicats de l'industrie routière française—Coalition of business associations of the French roadworks industry), and STRRES (Syndicat national des entrepreneurs spécialistes de travaux de réparation et de renforcement des structures—National business association of contractors specialized in structure repair and reinforcement works).

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