Inquiring urban ecology : failure and maintenance of Paris public bicycles

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ABSTRACT

This paper examines maintenance and repair work as forms of inquiry, experimentation and innovation in the city. Based on interviews and ethnographic observations with maintenance agents of the Parisian public bicycle scheme (Vélib), this paper show that the maintenance and repair operations which stabilise the service are primarily based on inquiry. Vélib's handling and resolution of practical problems tests a type of inquiry ethic which is central to the development of the technology. By describing the knowledge and know-how used by maintenance agents, we show how these maintenance agents, through daily contact with the city and users of the scheme, become sort of 'sociologists' on the subject of mobility and users. For these actors the urban ecology becomes a place of inquiry and experimentation, a space populated with uncertainty which they must repair and maintain using diverse instruments and practices. The aim was to trace the trajectory of Vélib' technology in the act of maintenance and repair rather than through seemingly stabilised and ready to use objects. This approach invites us to study the infrastructures of the so-called smart city from the perspective of its varying degrees of temporary and material opening, observing its successive reconfigurations in the field.

INTRODUCTION

To endure is to resist wear and tear. It is the conservation of an object after use. It is maintenance to ensure the object does not disappear. To inhabit a place is to maintain it. It is not possible to inhabit a place if we cannot manage to sustain it in a good condition.

J.M. Besse

Acts of maintenance and repair have an inferior status in urban life. They are routinely considered as less noble than the practices of the so-called 'creative class' (Florida, 2002), which emerge hand in hand with the *smart city* and *creative city* boom. Given the supposedly repetitive and grubby nature of the work, which is generally carried out by 'housekeepers', these acts are often overlooked when it comes to analysing sources of innovation in a city. From this perspective, maintenance does not 'manufacture' anything; it does not add value to the urban experience and is instead seen as an automated task that has very little to do with innovation.

However, by examining the case of the maintenance of the Parisian public bicycle scheme (Vélib), this paper aims to problematize this vision, demonstrating how maintenance and repair can be conceptualised as forms of urban innovation, and the city as a place of inquiry that is constantly open to respecification. Although the Vélib' programme can be considered as the relatively solid *black boxing*[1], we will see varying degrees of infrastructural flexibility in the practices of the maintenance and repair agents, and how the inquiry work of these agents comes to play a central role in defining Paris' mobility project.

As indicated by various authors (Star, S.L, 1999; Star and Strauss, 1999; Hannam et al., 2006; Graham & Thrift, 2007; Denis and Pontille, 2010, 2010a) carefully researching the sociotechnical organisations behind the mobility and circulation of objects and persons is an important, even political task. As indicated by Latour (2009), "*we can only talk about mobility because there is an immobile infrastructure. When the mobility of an element increases, the immobility of the infrastructure increases accordingly.*" (pg.9). By differentiating the research approaches which are focused on the so-called *mobility environments*[2], we aim to show other mobility categories, which could be described as *'the immobiles of mobility'* (Hannam et al., 2006; Latour, 2009). Instead of taking the movement of people and objects as an inevitable element, we will examine how this movement is enabled by those responsible for the scheme's maintenance.

We will examine the impact of failures on the programme and the forms of knowledge generated by these situations (Graham and Thrift, 2007; Dant, 2010; Denis and Pontille, 2010, 2010a). We will focus on the skills developed by the maintenance agents to identify failures and recognise their causes, changes and impact, in an on-going effort to find the best way of dealing with a service problem. Failures are described as elusive, subtle and sometimes invisible objects as their effect on the bicycles is never uniform or stable, their limits are unclear and it is difficult to know when they may appear or disappear. We will show that the uncertainty produced by failures requires agents to develop experimental operations in which maintenance work is not confined to restoring an object to its original state but involves active operations of knowledge production. The maintenance agents are not simply managing a transport system; they are active *mediators* and versatile experimenters of an infrastructure that is continuously redefining its relationship with the urban ecology. Through their daily interventions in the city, agents actively identify and solve problems, while formulating definitions of what a Vélib' 'user' is and should be.

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[1] It is important to note that the resources invested in opening a black box are always proportional to the resources used to close it (Latour, 1987).

[2] The rise of this perspective (*mobility turn*) has resulted in the proliferation of a series of terms, such as society-network (Castells, 2000), liquid modernity (Bauman, 2000), mobility environments (Bertolini & Dijst, 2003) homo mobile (Amar, 2010), moving spaces (Delgado, 2007), nomadic metaphysics (Cresswell, 2006), among others.

Similarly, this paper will show the centrality of the inquiry operations used by maintenance agents to identify, clarify and resolve problematic situations. Maintenance agents are continuously faced with indeterminate situations. According to Dewey (1993), indeterminate situations are inherent in all processes of inquiry, when people build their knowledge on the basis of situations declared problematic[3]. 'Indeterminate situations' are neither a handicap nor an obstacle to investigation: on the contrary, "*destabilising situations are the special moments through which the inquirer discovers what is at stake, because it is in these situations that the actors themselves come to realise what they had previously considered as acquired*"(Stark, 2009, p. 32). We will demonstrate that agents' empirical experience – faced with an urban environment that must be prepared for the scheme to work well – is littered with these indeterminate situations and that their actions are largely guided by the principle of inquiry and exploration. We will show that the implementation, maintenance and repair operations which stabilise the service, albeit in a fragile manner, are primarily based on inquiry. Vélib's handling and resolution of practical problems tests a type of inquiry *ethic* which is central to the development of the technology.

From an interactionist perspective, the act of repair can be defined as an activity that defends the associations that form a workplace social order (Henke, 2000:60), while from a symmetrical perspective (Callon, 1986), repair endows the socio-material world with continuity (Graham and Thrift, 2007; Denis and Pontille, 2010)[4]. In this paper we expand this socio-material sense of repair by focusing on the different forms of inquiry used. Within the act of repair, the scheme's social and technical identity is renegotiable and uncertain. Agents are only able to deal with problematic situations and become active mediators between the conceptual universe and the service users' world by engaging in inquiry.

Two ethnographic data collection techniques were used in our study. Firstly, we carried out observations by accompanying actors from JCDecaux directly involved in Vélib' maintenance: heads of sector and bicycle technicians or maintenance agents during their daily activities. Maintenance agents were accompanied systematically during full working days (from 06:30 to 14:30). Using field notes, photographs[5] and audio recordings, we documented the various operations and problems these agents encounter every day. Using the itinerary method (Grosjean & Thibaud, 2001), we reviewed these observations for what the actors describe as their own interventions in progress, their work sequences, rhythms, relationships with clients, and essential tools and techniques. Furthermore we conducted in-depth interviews with various key figures within the Vélib' system (director, head of workshops and inventories, head of operations), who do not necessarily have direct contact with the field, but who play a fundamental role in the organisation of the system.

INQUIRY INTO 'NATURAL FAILURES'

The relationship between most users and the Parisian public bicycle scheme is simply the visible result of multiple maintenance operations and practices which ensure the programme operates 24-7. Only when we see an abandoned, broken bicycle or no spaces to return the bicycle do we think (usually while complaining) about the distribution and maintenance of bicycles and possibly the company that operates the service. However, for any one of the scheme's 20,000 bicycles to be used is not just a matter of having users wanting to cycle in Paris; it requires above all an infrastructure of people and technologies throughout the city able to stabilise the programme.

The Vélib' bicycles have experienced significant wear and tear since their launch, in 2007: punctures, worn down brakes, rusted forks, broken chains and flaking paintwork. This tendency towards entropy is not a metaphor we devised as researchers but something the agents encounter frequently in their work. Maintenance is the only way of dealing with this constant deterioration.

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[3]Inquiry originates from a doubt associated with the indeterminate nature of the situation: "Inquiry is the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations that it converts the elements of the original situation into a unified whole" (Dewey, 1993: 169).

[4] Citing Harman's work (2002), Graham and Thrift indicate that immersion in places of disconnection and dysfunction is only possible if the idea of connection and coherence is acknowledged.

[5]With the exception of figures 1 and 2, all images were taken during our field observations.

One way of navigating through this world of anomalies and dysfunctions is to devise categories and distinctions. Thus the maintenance agents make a distinction between 'natural failures' – resulting from wear and tear through use – and failures caused by vandalism, which we refer to as 'social failures'. This second category of failures, resulting from antisocial acts, has caused the severest problems for the service:

A bicycle is used 80 times a day, causing wear and tear and natural failure of various parts of the bicycle. So numerous parts have to be replaced due to natural wear and tear. But if you add in vandalism, there comes a time when you can no longer balance the maintenance repairs, the natural product of the bicycle's wear and tear, with the repairs to failures caused by vandalism. (Interview with the Director of the Vélib' programme)

We are primarily interested in the agents' activities in dealing with failures they classify as 'natural'. The relationship between maintenance agents and failures emerges as the first important element. They do not perceive a Vélib bicycle as a passive and mobile system as most users do, but as a potentially dangerous object that may pose a risk to clients, incite vandalism and very often, cause problems for agents during their interventions. Although the *fluidity* of bicycles between stations enables the service to function, this fluidity also creates the biggest problems for agents. Freedom of movement of these objects is a permanent problem for maintainers.

On the metro or bus, I can anticipate your journey. However, with the freedom offered by the Vélib' system, I cannot tell which way you will go. We are victims of the freedom we give users, which makes maintenance all the more complicated. (Interview with the Head of Operations)

Bicycles requiring maintenance are permanently on the move, they do not 'communicate' their failures or problems; neither do the users, who will very often continue riding a faulty bicycle. Two years after the Vélib' scheme was launched a practice emerged whereby users would rotate the saddle backwards to indicate that a bicycle was faulty. The 'Vélib Users Committee', set up by the City of Paris and JCDecaux in March 2010 to improve the service,[6] proposed the idea of user-actors to establish the bases for client collaboration in the system's maintenance. However for those working in field on a daily basis, users' 'technical solidarity' (Dodier, 1995) was more anecdotal than real.

I think that this practice of rotating the saddles of faulty bicycles is misleading, because often users just do it to reserve a bicycle for later. If this practice were 100% reliable, then we would just have to check the bicycles with the saddles pointing backwards but unfortunately this is not the case. (Interview with the Sector Head)

Objects in movement, bicycles and users that do not report problems - and may even feign problems to take advantage of the system – make the question of having legitimate 'messengers' of failures a complex issue in terms of maintenance. Failures create situations that are difficult to understand; situations with no inventory of intrinsic properties; hybrid entities that are both human and material, fixed and mobile, technical and social, visible and invisible.

Making invisible failures 'visible'

Vélib's senior management and maintenance agents describe the problem of bicycle failures in *military* terms as a constant battle to identify problems and faults before users ride a faulty bicycle and cause further damage to the system.

We know there are a significant number of bicycles with problems but we do not know the type of problem or where they are; moreover it is almost certain that these faulty bicycles will continue in circulation, because a bicycle with an problem that does not prevent it from moving will continue to be used on the roads. It is a permanent battle against time and the users, a battle to outpace the deterioration. (Interview with the Head of Sector)

Failures that require an agent to block a bicycle are generally imperceptible to users. Agents must be able to not only manipulate unstable objects but also deal with users who simply want to find a bicycle and reach their destination.

Sometimes you are repairing a bicycle at a station, and you know that there is another bicycle beside you that you need to repair but suddenly a user arrives and takes it. But if the client is in a hurry or there are no other bicycles at the station, I'd rather say nothing if the problem isn't too serious. (Interview with Maintenance Agents)

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[6] To date there have been 16 meetings of the Vélib' Users Committee which have dealt with different matters put forward by the 20 committee members. There have also been guided tours to educate the Committee about the internal workings of Vélib'.

Failures do not present fixed identifiable properties as per the repair manual, but tend to remain concealed, affecting other parts and with other potential effects, on the wheels, the chains or the brakes of other bicycles used by other users. Rather than a dualism between human actions (agents who detect failures) and non-human actions (bicycles awaiting classification)[7], agents are uncertain as to the impact of failures because they do not know when and how these failures may manifest themselves, and who or what is acting. This is what makes the failures a matter of *inquiry*.

> The failures that can be found in the field are infinite, so all we can do is repair them whenever we identify one. But it is one failure out of the thousands that there must be, because the bicycles are not going to tell us 'listen, I have a problem and I am in such and such place' and it is entirely possible that this bicycle circulates for weeks without anyone spotting the problem. (Interview with Maintenance Agents)

Bicycles and failures are referred to as *actors* in the sense that the bicycles can conceal or even reveal their problems. The challenge lies in detecting the failures that are not easily visible and which can be potentially dangerous for users. The agents' work is not limited to repairing failures but also anticipating potential anomalies and recognising how these anomalies alter the experience before they become 'major problems' for the maintenance agents. Maintenance work therefore depends largely on this ability to identify certain traces (Ginzburg, 1989), in order to designate a specific bicycle as being in need of servicing. According to Ginzburg, the trace constitutes a mode of indirect and indicative knowledge of the world: traces do not exist in isolation but are always a reference of something else. In our case, the traces identified by agents must be interpreted not only in terms of causalities but also of effects and resistances.

We are not suggesting that failures are constructed through observation or classification; or that the failures originate when they are detected by maintenance agents. This type of constructivist perspective ignores what we believe is the most important feature of the failures: their effects. Our aim is to highlight the different ways these failures exist and, in this case, their state of latency or state of *plasma*, to use one of B. Latour's concepts (2007). Failures are not only present when they are identified or repaired, they are also present in an intermediary state in which they are not totally visible and understandable and, therefore, their effects are not the same. Latour defines the plasma state "which is not yet formatted, not yet measured, not yet socialized, not yet engaged in metrological chains, and not yet covered, surveyed, mobilized, or subjectified (Latour ; 2005, p. 244).

We are not trying to portray an *essence* of failures whereby failures are static entities readily available for observation. From this perspective, anomalies would be limited to the scheme's technical properties. The failure would be defined by the object's material properties, regardless of how these failures are interpreted. Similarly, we reject the constructivist perspective of failures as social constructions in which failures only exist because they are categorised and anomalies are born from the classification system; whereas in the first perspective it is only the object's essential properties that would deem it 'out of service'. In contrast, we have tried to show that failures are not confined to either the properties of the object, or the classification process carried out by maintenance agents because, empirically, this distinction becomes blurred in the agents' concrete activities. Maintenance work is not based on static entities but on the temporary traces of failures and bicycles in their various states of transformation and problematisation. To some extent it is this task of making failures 'visible', where human and non-human competences are interwoven, that makes the maintenance of the Vélib' scheme a fragile act of permanent investigation.

Agents as explorers

Examining the maintenance operations revealed that the primary material with which agents must intervene – the failures- is both diffuse and elusive, discreet and progressive, visible and invisible in nature. We could use Dewey's notion (1993) of 'diffuse quality' to refer to the elusive *action* of failures on the Vélib' service. The elusive and non-standardised nature of failures requires agents to adopt an attitude of inquiry and exploration.

Faced with anomalies, agents often find experimental solutions, responses that are reliant on their engagement with action and *transactions.[8]* Maintenance capacities are produced through interaction (Henke,

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[7] For a theoretical development on the question of dualism, see notably Callon (1986) and Latour (1994).

[8] Again we borrow Dewey's concept of 'transaction' (1993) by emphasising a specific feature of the maintenance agents' activities, which is their insertion and continuity within the city's urban ecology. Dewey perceived experience as a permanent transaction between an

2000:61); resources are discovered through the circumstances maintenance agents find themselves in. It is a form of knowledge that cannot be mastered internally; it is not a transferable inventory of information but something that is produced through action. For example agents utilise the urban environment (station location, time of day, type of people, etc.) in their maintenance work and even to determine the nature of the failures.

> I am accompanying a maintenance agent called Vincent. He is responsible for station number 13104, situated in the Quai d'Austerlitz. It is 8:30am. It is a large station with capacity for over 60 bicycles. Vincent is working quickly, because he knows that users will arrive suddenly to take the available bicycles. The agent spends only a few moments answering my questions. I see him concentrating fully on repairing the bicycles and overseeing the station in general. From time to time he communicates with head office via his mobile phone to request the blocking of a terminal that he is unable to repair.

However, users arrive at the station to collect or return bicycles much faster than he can repair the bicycles. I decide to interrupt the agent to ask him if he can tell what kind of different types of anomalies he will encounter by city neighbourhood.

> "Generally, depending on the station I am going to work at, I calculate which spare parts to take with me. Depending on the sector, you know more or less which parts will be broken and which will resist. But with maintenance there are no norms, because you can always find different problems, it is impossible to plan ahead and planning and monitoring maintenance is only a guide, because something unexpected always happens and needs to be fixed depending on the situation and each agent does that his own way." (Interview with Maintenance Agent).

Vincent in some way alludes to Dewey's concept of inquiry when talking about his experience with failures. A practice of inquiry inevitably creates links between uncertain or problematic situations and a choice of possible solutions. Therefore the definition of a problem (or failure) is inseparable from the task of inquiry. The problematisation or identification of a problem is the first step in the investigation process: "discovering what is or are the problem(s) that a problematic situation poses to the inquiry is to be well-advanced in the inquiry" (Dewey, 1993: 173). Hence Dewey presents the concept of inquiry as an uncertain situation where the thing one is looking for is not known in advance and emerges as the result of a series of different tests:

> There is not at first a situation and a problem, much less just a problem and no situation. There is a troubled, perplexed, trying situation, where the difficulty is, as it were, spread throughout the entire situation, infecting it as a whole. If we knew just what the difficulty was and where it lay, the job of reflection would be much easier than it is….In fact we know what the problem exactly is simultaneously with finding a way out and getting it resolved. (Stark, 2009, p. 2)

Failures are not inherently a problem, they only become problems when they create an uncertain situation for action because for a problem to be articulated it must first be experienced (Dewey, 1993). The notion of problem put forwards by Dewey implies therefore an episode of rupture in a subject's activity, a rupture that prompts the search for the necessary means to clarify an uncertain situation and propose a solution to the problem. According to Dewey, a problematic or confused situation raises emotions and questions, putting into motion the actions of inquiry, clarification and elucidation. Without the *experience* of a problem, there is no motivation to create and explore solutions.

For Vincent, the solutions to failures are not determined by a series of pre-set parameters. As he says, 'it is impossible to plan ahead', which takes us back to the premise of an inquiry adapted to a given moment. The truth of a failure, its solution, does not precede the situation that may occur. As the agent says 'something unexpected always happens and needs to be fixed depending on the situation'. The unstable nature of failures requires field agents to have an open attitude to accept this uncertainty.

This coexistence with uncertainties is also evident in the agents' daily work as a considerable part of their day is spent constantly *adjusting* and experimenting and in some cases, actually innovating.

One of the most common problems encountered by agents are punctures. Punctures are so frequent that at least once a month agents need to replace their worn-out bicycle pumps. The seemingly simple task of repairing a puncture is in fact very time-consuming as the bicycle must be dismounted from the terminal and the wheel removed. Vincent explains that these failures are 'laborious' because while they are technically straightforward, repairing it quickly requires the right position. He describes how through his experience of these types of time-consuming problems, he devised a *technique* to repair a puncture without removing the wheel. According to the agent, this 'little trick' saves him huge amounts of time.

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organism and its environment, superseding the dualism that tends to consider these two entities as autonomous and independent, and therefore posing the idea of the *continuity* or the *phases* of the experience (see Karsenti and Quéré, 2004).

Fig. 9. Agent repairing a puncture

Fig 10. A tyre changer in the docking terminal

The technique developed by the agent involves wedging the tyre changer between the edge of the bicycle and the docking terminal (see Fig. 9). This trick allows Vincent to elevate the wheel a few millimetres from the ground (see Fig. 10), giving enough space to replace the inner tube without having to remove the wheel. Vincent describes the trick as 'a little innovation that saves [him] time and lets [him] fix a typical failure that [he] personally finds laborious'.

According to the agent, the routine activities of his job (such as repairing punctures) are to some extent opportunities for innovation. Failures create a space for exploration, or as Vincent says 'little innovations' in the field. The act of maintenance is closely associated with exploration and in this respect maintenance is learning (Brand 1994; Graham and Thrift, 2007). Henke (2000) even suggests that improvisation is one of the key elements in the practice of repair. Vincent's case also takes us back to the question of the effects of failures on agents' work. Solutions that are not yet formulated open up the possibility of new combinations and associations. David Stark considers that the privileged spaces for innovation are the realms of ambiguity and uncertainty, as this is where actors are compelled to reassemble their knowledge and techniques. To cite Stark: "[…] because innovation, in this view, involves bringing together incompatible traditions, we should not expect that the process will be harmonious" (Stark, 2009, p.3).

Maintaining and inquiring about users

Vélib's materiality (docking terminals, bicycles, etc.) is continually involved in updating the social and spatial order consisting of practices and discourses from users and non-users distributed within the public space. With its exposed nature and city-wide presence, Vélib' interacts powerfully with the urban environment in which users' demands, road traffic regulations, weather conditions, tourist practices and acts of vandalism are interwoven with many other situations that can occur around a station. Vélib' not only occupies a specific urban space; it also forms it, in the same way that technology is formed by the urban space in which it is inserted. The identity of the space is not fixed or determined from the outside, but in fact always exists as a possibility constructed from the different objects that equip the city (Law, 2000)[9].

Maintenance agents have privileged access to this co-construction between Vélib' and the urban space and actively participate in its elaboration and reproduction. Therefore restricting agents' activities to a material maintenance disconnected from the rest of the Vélib' service would be unfair and empirically incomplete on the part of the analyst. Failure maintenance acts within a continuous process which needs no distinction between 'material failures and inquiries' and 'user-related failures': the failure is as 'technical' as it is 'social'. There is a close articulation between repair activities oriented towards objects and those oriented towards people. Agents develop specific skills on how to adapt users and technology and create precise definitions of their practices and difficulties. They must constantly reconcile the projected users (user types) of the Vélib' technology and the real users, for example the tourists who have never used a self-service bicycle before. Agents not only have an extremely rich sociological definition of users, they also make permanent adjustments in situ to harmonise the technology with the user, and the user with the technology.

We are at a station near Opéra, in the 9th arrondissement of Paris. I notice that the agent has started talking to a user who is returning a bicycle to the station (Fig.12). He explains to her that next time she should secure her bag inside the basket as otherwise it is very easy to steal. He shows her how to do this by passing the shoulder straps round the handlebars of the bicycle, explaining that he has seen numerous robberies. The woman is impressed but also grateful for the information given by the agent about how to use the Vélib' bicycles more safely.
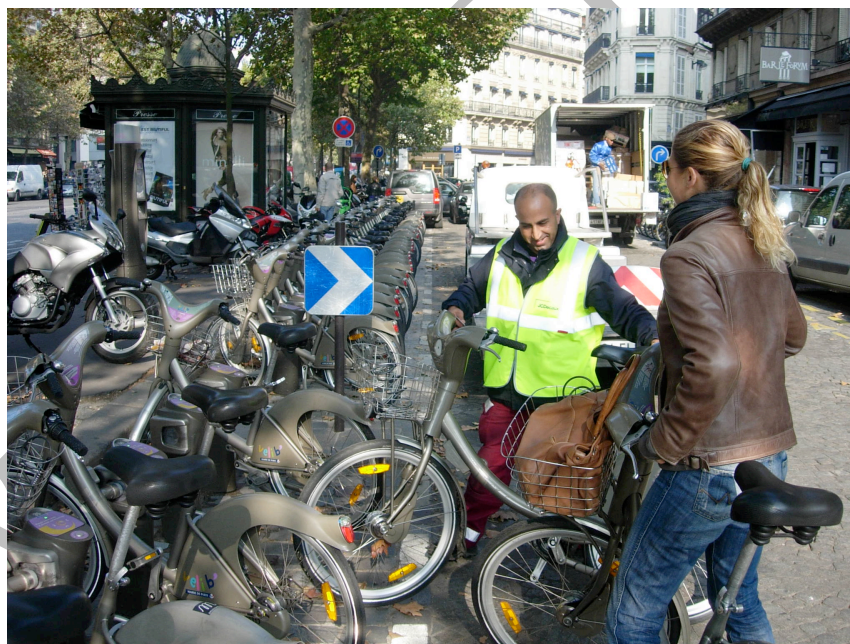

Fig. 12. Agent talking to a user

This highlights how agents participate daily in the construction of the Vélib' users. This urban mediation by maintenance agents highlights two important elements. Firstly, the agent reconfigures the relationship between the user and the technology, making the user act differently – because next time our user will probably secure her bag to the basket – and secondly, the bicycle is no longer just a means of transport, it has also become a *medium* for a potential robbery. Therefore maintenance agents' work cannot be summarized as simply an

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[9] This critique of the absolutist conception of space is found in the works of Lefebvre (1974), or again in Nigel Thrift (1996) and the article by J. Law and A. Mol (1994).

'update' or 'connection' between the conceptual and the users' worlds, because through their interventions agents frequently redefine the nature of scheme.

Thus the agent prescribes how the scheme should be used. We know from the works of d'Akrich (2006)[10] that any innovation project should *position* the technologies within the representations of action and environment in which the technology will evolve. The scripting of future users (*scripts*) by designers and engineers defines an action framework (*framing*), i.e. how 'normal' users should behave with the technology.

Nevertheless, we find that maintenance agents do not simply update the pre-defined scripts (as would be the case of a maintenance agent showing tourists how to rent a bicycle), they also participate in producing new scripts, i.e. the instructions that agents create in situ. The cognitive and corporal process of securing a user's bag to the bicycle's handlebars is not part of the designers' scripts and discourses[11]. It is a process introduced by agents on the basis of what they have learnt in the field. Agents do not limit themselves to updating the scripts (skills, attitudes,) that were predefined and projected by the scheme's designers but are spontaneously creating and defining what needs to be done to become a safer Vélib' user. This appropriation by the Vélib' agents compels them to explore new possibilities and produces developments that enable the programme to be better adapted to its environment[12]. Here we have another form of inquiry into Vélib' users' behaviour: agents are continually determining the best way to maintain/repair certain user behaviours, trying to discipline users to adopt behaviours that the agents themselves consider as safer.

INQUIRY INTO 'SOCIAL' FAILURES

In this section we describe agents' working conditions and schedules and the ways they classify and record 'vandalism'. We see the emergence of a situated knowledge among agents in the way they record vandalism, discuss and contextualise it and the skills used to understand and deal with it.

During our study agents explicitly expressed their interpretations of the 'antisocial' acts that affect the Vélib' scheme. It is clearly an acute issue for those responsible for the system: records show that by 2010, 8,000 bicycles had been stolen and more than 16,000 had been damaged or 'vandalised'. Of the 16,000 bicycles that were vandalised between 2007 and 2010, half had to be replaced[13].

Agents discuss vandalism readily. Efforts have been made to understand the causes and motivations for these acts. Agents are permanently trying to de-singularise (Boltanski and Thévenot, 1991) anti-social behaviour, exploring ways to synchronise the local situation with a more general framework of interpretation[14]. Although this quest to de-singularise acts of vandalism may draw on different aspects and contents of the agents' descriptions, there is a common tendency towards 'increasing generality':

I have worked here for several years, and for me the issue of vandalism is linked to a question of social differences. Sometimes I get the impression that we are working to maintain a service for the '*bobos*' of Paris (the 'bourgeois-bohèmes' trendy urban middle class). If you think about it, working class people who get up early and go to work at 6:00 or 6:30 in the morning, don't really feel like taking a Vélib', particularly if they work outdoors, often doing manual labour. Also, people use Vélib' to avoid the morning rush hour in the metro, all the stressed people, which is really unpleasant. But at 6:00 in the morning the trains and metro aren't as busy. It's people who spend all day stuck in their offices who want to use the Vélib'.
(Interview with Maintenance Agent)

This raises the question of how Vélib' is perceived by different social groups, and according to the agent vandalism should be considered from this angle. The agent puts a value or principle first and foremost (in this case, social justice relative to different lifestyles) to explain acts of vandalism. He is engaged in a descriptive

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[10] See also Pinch and Oudshoorn (2003) or Wilkie and Michael (2009)

[11] In the Vélib' user's guide, which can be found at http://www.velib.paris.fr/Comment-ca-marche/La-securite, the only reference to theft stipulates the following: 'when stopping, even for a short time, attach the bicycle to a parking hoop with the padlock provided'. No reference is made regarding how users should look after their belongings in the basket.

[12] Julian Orr (1996) developed a similar argument, by showing that the repair agents do not necessarily follow formal manuals and procedures provided by the hierarchy, and that their knowledge of repairs is very often gained and improved through coffee break conversations.

[13] In May 2010, the Paris Mayor's Office launched a public awareness campaign on 'user care' to tackle vandalism, with the slogan 'Beating up a Vélib' is easy…it can't defend itself'.

[14] For the relationship between general resources and specific situations, see Dodier (1993).

activity, a system of individual understanding, which will have practical effects how he organises his maintenance work. Effectively, his understanding of vandalism will act as a situational or empirical anchor to his daily operations. The same agent explained to us:

> In affluent neighbourhoods there is less damage to stations and bicycles than in the working class neighbourhoods; yet in the working class neighbourhoods there is more respect and understanding for our work. Users in the centre of Paris are always in a hurry and stressed, they barely say good morning or thank you to us. (Interview with Maintenance Agent)

From his experience in the field, the agent views vandalism in a way we could term empathetic: in working class neighbourhoods there is more vandalism but residents have more respect for agents' work. By explaining damage and vandalism in sociological terms the agent is attempting to position the Vélib' experience within a broader category. Maintenance agents feel entitled to express their opinions about vandalism, because they feel their experience gives them knowledge of the city and its forms of urbanity.

> The type of damage to bicycles varies a lot between the north and south of Paris. In the north you find wilful acts of vandalism, slashed types, bent frames, etc. But there is less vandalism in the city centre because these areas are busier, people don't dare to vandalise, because the ones who break the bicycles are generally non-users. (Interview with Maintenance Agent)

The notion of non-user

Let us consider for a moment this reference to the spatial behaviour of vandalism and the notion of the 'non-user'. This term clearly shows the types of situated knowledge agents can produce. The scheme was implemented spatially and socially taking into consideration the users, their preferences and transport needs. Yet it has become apparent that the vast majority of acts of vandalism have been committed by 'non-users'. This category of users, generated by the maintenance agents themselves, has a significant impact on the way that maintenance work is organized and the fleet of bicycles is managed.

> We know that if we don't repair stations or bicycles for a long time, they will be vandalised, and by people who are not necessarily users but are just passing by, a bit drunk, who mess around with the bicycles, college kids near schools, etc. (Interview with Maintenance Agent)

We do not know if the 'non-users' category refers to people who feel excluded from the system for technical reasons, or people who resist using it for social or other reasons[15]. Nevertheless, it is interesting to see how agents have devised this category based on their experiences in the field. The act of categorising a certain profile with specific characteristics and moral intentions requires an ability to make links and associations, generate scenarios or scripts of behaviours that are shared by certain groups. However this 'construction' of profiles is not done during the service's design phase by experts, spokespeople or through statistical studies. Agents construct this category of users *in action*, based on the social, spatial and material *inquiries* available in the field.

Vélib' faced with mass crowds

Strikes and mass protests create testing situations for the entire service. Faced with emotions running high and crowds of people who are not necessarily Vélib' users, the service experiences a technical and social transformation. This is when Vélib's regulatory and maintenance procedures must function at optimum capacity as these situations pose high levels of unpredictability and risk. If the Vélib' programme's aim is to become routine for its users, as normal as taking the metro every morning, this 'normality' is severely affected on strike days and can be overwhelmed by users and situations that are far from predictable.

During our study, national protests against the government's pension reforms turned Paris into a stage for numerous public demonstrations. Maintenance agents know that however much they may plan and prepare prior to a demonstration, it is never enough to deal with the aftermath of an event on this scale. As part of the urban setting, Vélib', like many other elements of the urban furniture, is affected by public demonstrations.

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[15] Sally Wyatt, for example, in her paper on the development of Internet technologies ("Non-Users Also Matter: The Construction of Users and Non-Users of the Internet"), makes a distinction between various types of 'non-users' according to their differing motivations: 'resisters' and 'rejecters'. For a critical analysis of this work, see Flichy (2008).

Strike days are good for Vélib' in terms of the number of journeys made (as other modes of transport are collapsed or out of service), but they also result in the highest number of acts of vandalism.

When the strike ends the agents reopen all the stations that were closed for security reasons and restore order to the Vélib' network. As the city tries to return to normality, the aftermath of the crowds of protesters becomes apparent.

At about 15:00hrs I join one of the maintenance agents responsible for opening the stations in the Bastille area. Everything seems normal and apart from some flyers and stickers on the ground, there is no indication that there was a large protest here the night before. Just then the agent receives a call on his mobile from his Head of Operations (HO).

HO: What's the situation? Much damage?

MA: I'm just removing the orange plaques from station number…and then I'm going to check the electronic problem at the other station.

HO: Ok, and not too much damage?

MA: Normal, not much in the stations at the moment but lots of wrecked bicycles, all over the place. I've found three at least already.

HO: Fine, let me know when you fix the problem at the station[16].

This conversation reveals the mood of Vélib's senior management after a public protest. Knowing that after a rally there will be an unusual amount of damage; this is the first question the Head of Operations asks the agent. But what does the agent mean when he talks about wrecked bicycles? Bicycles vandalised by protesters? Agents will interpret these acts of vandalism as the consequence of emotions running high.

On strike days there is more demand, and of course more people use Vélib' when there's no public transport, so we have to constantly replenish and free-up space in the stations. But it's a very precarious time because people are agitated so if they don't find a space to leave the bicycle, they may become violent or just leave the bikes anywhere. That's why when there are protests you find damaged bicycles all over the place. (Interview with Maintenance Agent)

It is not always 'non-users' who cause damage but, as the agent says, users of the service who are in an agitated state. Given that public transport runs less frequently on strike days, demand for Vélib' increases significantly, as does the desperation of users trying to find or return a bicycle. This is when the diffidence and civic behaviour of the Vélib' user gives way to emotional outbursts; urbanity and respect are replaced by small acts of disobedience.

Figure 16: Bicycle with a puncture and bent frame

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[16] Field notes.

Although the act of continuing to use a bicycle even though it has a flat tyre may seem harmless, for the agents it is an antisocial act that causes as much damage as someone wilfully damaging a bicycle. The urbanity of the user seems to be temporarily suspended as emotion and agitation invade the public space. Maintenance agents witness this change amongst the users and also from the state of the bicycles left abandoned in the streets. What is interesting about the agents' descriptions is the way they describe the *work of emotions*[17] on the Vélib' during protests[18].

When De Laet and Mol (2000) studied the case of the water pump introduced in Zimbabwe, they noted that the success of a technology lay in its capacity to adapt to a situation, to make its properties malleable according to different environments. The authors suggest that the pump's adaptability is in its capacity to constantly renegotiate its limits (material, hydraulic, social, and geographic), and in the integration of different elements of its environment into its operation (De Laet and Mol: 252). From this perspective, the acts of vandalism endured by the Vélib' scheme are part of the numerous socio-technical interactions between technology and its environment. Vélib's permanence depends on its capacity to resist and mutate according to the event or situation it faces. Its stability is not based on a 'black box', but depends on its capacity to adapt to an adverse and unstable environment. The infrastructure must be inserted in the city in a way that is sufficiently robust to transport thousands of clients every day but also sufficiently flexible to be able to modify the operational protocols that ensure its permanence. Within this process, maintenance agents inquiry work is part of the laborious adaptation process that Vélib' faces day after day. In their activities, agents produce knowledge that allows them to evaluate the condition, failures and transformations of the Vélib' programme.

URBAN ECOLOGY AS A PLACE FOR EXPLORATION

By emphasising the significance of the maintenance agents' operations, we are able to understand the Vélib' city not as a stable and intrinsic entity, but as an entity that must be continuously created. The aim is to trace the heterogeneous trajectory of Vélib' technology in the act of maintenance rather than through seemingly stabilised and ready to use objects. Through the maintenance operations we have attempted to examine one of the Vélib's modes of existence, showing that these distributed and local practices influence the durability and perpetuation of the system. As Denis and Pontille (2010a) suggest, this approach allows us to problematize the question of modes of existence and the development of objects, as 'maintenance takes effect when people develop the capacity to perceive differences within a system of objects that may appear stable at first glance'. Denis and Pontille show that the static relationship (in terms of immobile objects) between users and the Paris subway signs changes when viewed from the perspective of those responsible for repairing the signs, for whom these objects are subject to permanent wear and tear and transformation. In this paper, we have observed something different: whereas the relationship between the majority of Vélib' users and the bicycles is one of *mobility* (objects which they expect to find ready for a journey), we discovered that the maintenance agents relate more to the immobility of the objects, as it is only when the bicycles are stationary that agents can carry out their repair work.

To some extent this paper is in keeping with the sociological approaches to technology which have extensively described the way in which designers and producers think about the future development of a technological object[19]. These studies have revealed how technological objects have an extremely delicate implicit 'sociology' as regards the behaviour of clients and users of future technologies. These studies tend to focus on the role of technology innovators and designers, the controversies engendered by these technologies and the negotiation in the design process; however they sometimes give the impression that the

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[17]Louis Quéré (2012) uses the term 'work of emotions' to refer to the role the emotional dimension can play in the formulation, perception, definition and solution of a public problem.

[18] The emotions associated with Vélib' are part of the multiple activities created by the technology. In the song by Philippe Katerine called *Parivélib'*, it says: 'If I can give you a piece of advice, take the Vélib' at night on ecstasy'. Agents also describe night time as a particularly complicated time due to inebriated users.

[19] Here we are primarily referring to the works of the SCOT tradition (*Social Construction Of Technology*), initially led by WiebeBijker and Trevor Pinch (1987) and the development of the 'Safety Bicycle'. For a complete analysis of these approaches, see Vinck (1995) and MacKenzie & Wajcman (1999)

implementation of these technologies is the prolongation of a network built by the designers of the innovation (Vinck, 1995)[20].

We have shown that the life of an object is reconfigured during the field deployment phase, which poses once again the question of its identity and its biographical possibilities in terms of its articulation with the environment and contact with users (Akrich, 2006). Through their work, maintenance agents are continuously *re-specifying* the scripts, redefining the frontiers between the design world and the deployment world. As Vinck (1995) noted, the constitution of an artefact is not only the result of design and manufacturing activities but extends through the phases of deployment, use and maintenance. Therefore, instead of talking about 'interpretative flexibility'[21], where the Vélib' object would remain stable amidst various superimposed interpretations, we should focus on the idea of multiple ontology (Mol and Law, 1994) which allows us to consider the mutations of the object consistent with the practices in which it is inserted. Vélib' acquires a distinctive socio-material identity in its maintenance practices which is primarily characterised by failures and anomalies rather than by stability and movement.

Various studies deal with the question of *innovation intermediaries* (Von Hippel 2005; Howells, 2006; Stewart, 2007) but leave open the question of the potential role of *maintenance agents* in reconfiguring and adapting technology to its environment. These studies reveal the presence of various intermediaries in an innovation process (users, organisations, technologies, distributers, buyers, advertising agencies, consultants, etc.) whose role in the adoption of the innovation can be seen, for example, in activities of knowledge production, inspections or dissemination. With the exception of the concept of lead user developed by Von Hippel (2005) these studies give preference to intermediaries with a 'technical background', i.e. experts who do not play a 'supporting' role like that of the maintenance agents in this study[22]. Therefore, in answering the key question of the asymmetry between users and designers[23], or the alignment between technologists and users, responses are based on feedback provided by users or other comparatively invisible intermediaries but not on the maintenance and repair practices.

Our argument has been that it is possible to extend the notion of *innovation intermediaries* by including the maintenance and repair agents activities,[24] showing how these operations can be conceptualised as forms of inquiry that respecify the infrastructure's durability and perpetuation. These actors must be able to articulate, in their maintenance and repair work, the designers' or programmers' original representations of users, while also exploring new ways of furnishing these concepts based on actual events and their field observations. Through their inquiry in the city and with the scheme, agents become specialists on users and actively participate in defining what a user of public bicycle system is and should be. Maintenance agents have to adapt the notion of Vélib's 'projected users' to the 'real users', adjusting the scheme's technical choices to its real, everyday environment. In their repair operations, maintenance agents update not only their knowledge of the scheme, but also their knowledge of the multiple interactions between the scheme and its environment. In this respect, our aim has been to show that maintenance work is inseparable from the relatively formal inquiry operations. Repair is not simply an action that seeks to restore the original *status quo;* repair is in fact an operation that permanently re-interrogates the scheme's materiality and its multiple interactions with its environment, producing new knowledge and hypotheses in relation to the service's socio-technical ecology.

Therefore we say that the agents act as mediators, in the sense Hennion (2002) attributed to this term: the agents are not simply carriers of standardised information about the field, or intermediaries between designers and users; they develop new entities and associations for the scheme through their maintenance work, proposing new definitions of action and users, the urban environment and its interconnections. The scheme is therefore not just a combination of technical choices made during the design phase and users; it is also the

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[20] If studies regarding 'users' (Oudshoorn and Pinch, 2003 ; Mackay, 2000 ; Stewart, 2007 ; Flichy, 2008) address objects in their usage, the central question in these studies focuses more on forms of 'domestication' of technologies than forms of stabilisation and production adopted by the technological object.

[21] This expression refers to the different interpretations attributed to a technological object during the concept and design phase. The success of an artefact is the result of the reduction of this process of 'interpretative flexibility' (Pinch and Bijker, 1987).

[22] Orlikowski (2000), in an attempt to move beyond the linear scheme of 'producing' and 'consuming', analyses the role of technology 'installers' (or support staff) by examining various empirical cases within organisations, however these installers are still typically expert consultants.

[23] Boullier (1997) clearly suggests: "the dominant characteristic of users supports the asynchrony of adjustments between the 'end user' and the 'designer-producer'" (p.13).

[24] The theoretical approaches of the activity or the 'work in progress' (Bidet 2008 ; Licoppe 2008) undoubtedly contribute towards understanding this re-conception and appropriation of the work by operators..

result of the maintenance agents' adaptations and inventions. This allows us to reconsider the trio of designer-intermediary-user not as ontologically stable figures but as states or trajectories that are revealed through the tests carried out on the Vélib' object. There are not two distinct worlds: a world of ideas and inspiration exclusive to the design phase and another that we could call the deployment world that is limited to replicating pre-established ideas. The maintenance agents show us that this contradiction between ideas and their execution is far more complex and is subtly dispersed within a permanent cycle.

For the agents, the urban ecology (with its stations, spaces, failures, bicycles and users) is a place for exploring and experimenting new adjustments, a space populated with uncertainty which agents must repair and maintain. In his works on the city of Chicago (1929)[25], Robert Park established the notion of the city as a place of experimentation, where the researcher tries to intervene in the urban ecology from a material and normative perspective. Park highlighted the artificial nature of the city, referring to it as an 'artefact', whose sacred and absolute dimension has been replaced by a 'pragmatic and experimental' character (Park; 1929, p. 3). Inspired by pragmatism, he proposed the idea of the city as a 'social laboratory'[26], describing the different forms of urban life from this perspective. Thus the city is a privileged place for a social science researcher to experiment by analysing the protocols and instruments that construct and maintain the urban territory.

If we take the role of maintenance agents and the different inquiries they use in their field work seriously, it is because, like the social science researcher described by Park or the scientist evoked in the 'laboratory studies' (Doing, 2007), the agents are constantly redesigning the properties that give life to the Vélib' experience: collecting data and testing the state of the bicycles, upgrading stations and guiding users, maintaining wheels and chains. By using their knowledge, instruments, inquiries and representations of users, agents play a key role in the organisation and opening of the Vélib' technology. Vélib's reality is experimental because it is only through the agents' experience and significant involvement in the field that the infrastructure will find temporary forms of stabilisation. The experimental nature of the infrastructure does not obey a position of principle made by its promoters, or a programmed organisational characteristic. It is the outcome of numerous efforts to update the multiplicity of elements that make up the infrastructure.

Therefore, instead of considering the notion of 'urban laboratory' as a rigid label for classifying a 'new' intervention, we have tried to convey it on the scale of 'foot soldiers' engaged in the activity of producing the service. The reproduction of the inquiries made by maintenance agents to tackle failures and their *agentivity* within the service reveals a type of "laboratory" (Park, 1929) that intervenes and contributes to shaping the agents. The French capital not only has the most extensive public bicycle technology (Tironi, 2014) it is also – in a far less visible, more local and distributed manner – a vast terrain of exploration and experimentation where knowledge and techniques relating to urban ecology are being tested. If this premise is to some extent in keeping with the *urban laboratories* field of research (Heathcott, 2005; Karvonen and Heur, 2011; Evans and Karvonen, 2011) in which the notion of experimentation is used to qualify certain urban projects, we must admit a degree of dissatisfaction with this process. There have been few empirical studies to date that adequately demonstrate the insertion of the notion of *laboratory* and *experimentation* in the contemporary urban space (Tironi and Brice 2015). If we talk about 'laboratory', it is not to denote a given state of affairs or ensemble of fully controlled protocols, but to describe a process of exploration and resolution of uncertain problems in the Vélib's maintenance and infrastructure.

This perspective requires us to reject the notion of experimentation as a position of principle that is external to the actors and question the substantialist approaches to urban infrastructures (Farias & Bender, 2009). At the same time, this approach invites us to study the infrastructures of the so-called smart or creative city from the perspective of its varying degrees of temporary and material opening, observing its successive reconfigurations in the field. The Vélib' service is an infrastructure that is permanently developing; the practices and knowledge that ensure its maintenance require opportunities for experimentation to guarantee its permanence.

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[25] For an analysis of the Chicago School, see Grafmeyer and Joseph (2004). See also Gieryn (2006).

[26] We found a certain similarity between the expression 'social laboratory' and Callon's notion of 'open-air research' (2001). See Tironi & Laurent (2015).

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