**What if nothing happens?**
**Street trials of intelligent cars as experiments in participation**

Noortje Marres (University of Warwick)

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**Abstract**
This chapter evaluates an emerging paradigm for testing intelligent technology in society through the analysis of recent street trials of self-driving cars. Moving beyond laboratory-based test protocols, street trials of intelligent automotive technology evaluate their performance in social environments, on public roads. As such, they appear to exemplify an experimental approach to the introduction of technology to society, which extends "beta-testing" procedures from technical to social, ethical and political aspects of technology (Jackson et al, 2014). I examine this hypothesis through a discussion of several street trials of intelligent automotive technology: the roll-out of driver-assist by Tesla; an emission test of a VW diesel car in Germany; the Gateway trial in Greenwich (UK). Each of these street tests puts in place arrangements for social engagement with intelligent automotive technology, but they *do not enable an experimental approach to the societal evaluation of technology.* While these projects tend to pursue the societal acceptance of technology, they do **not** curate experimental situations in society in which the proposition of self-driving cars can be examined from a societal point of view. However, the contribution of social research should not be limited to diagnosing methodological limitations of current tests of intelligent technology in society. We should examine if street tests can be re-purposed to enable the elicitation of societal aspects of innovation. I then conclude with a description of an 'experiment in participation' (Lezaun, Marres, Tironi, 2016) in which our team deployed creative methods to elicit social issues raised by driverless cars, by way of a group exercise conducted in the Driver-in-the-loop simulator at the University of Warwick (Marres, Kimbell, Cain et al, 2017). The explication of social aspects of inteligent technology requires the deliberate adaptation of test environments in society.

**Introduction**
In recent years, industries and governments have made significant investment in so-called real-world testing of intelligent car technology in everyday environments, on public roads. These tests take different forms, from the large-scale roll-out of experimental driver-assist technology by tech companies like Tesla, to government-funded field experiments which demonstrate new transport concepts such as the driverless buses called WePods, which

introduced 'mobility-as-a-service' into urban streets in the Netherlands and Germany, and the Gateway trials in Greenwich (UK) which placed driverless pods on a pedestrian path along the water front (Figure X). On-the-road testing has a long history in the automotive sector, going back to at least the 1930s (Dennis and Urry, 2009). So do efforts to render cars intelligent: some components of automotive systems, like fuel injection, have been controlled by computers, not just mechanics, since the late 1960s, and today most cars run software to do anything from breaking to navigating to steering.[1] While some experts today claim that in 5 to 10 years it will be feasible for cars to "drive themselves," others have emphasised that some technologies that today are labeled as enabling 'autonomous' driving are not as new as is often thought: they have been customary in higher-end vehicles for some years already, like the pedestrian detection systems of Volvo cars.[2] However, while the newness of on-the-road testing and of the computational enhancement of cars can be debated, there are also other reasons to take an interest in these trials: *a distinctive approach to the introduction of technology to society is detectable in today's street trials of intelligent cars,* and it is this I want to examine here.

In their study of an urban trial of an electric car-sharing service in St Quentin (France), Laurent and Tironi (2015) argue that such a street test is exemplary of a new, "experimental" mode of industrial innovation. They contrast this local experiment with an older, more centralized approach to the introduction of automotive technology to society. Instead of constructing "complete socio-technical systems in-house," car companies today increasingly enter into partnerships with a variety of other agencies in government, business and society in order not just to implement a new form of transport, but to configure "a whole ecosystem," in which the role of each of the above agencies is at stake (Laurent and Tironi, p. 211). In the test studied by Laurent and Tironi, for example, Renault envisioned itself in the role of no longer just a manufacturer of cars, but a "provider" of mobility solutions in partnership with IT companies and municipal government (on this point see also Wentlandt, 2016). In what follows, I will query the extent to which such street trialling of automotive technologies qualify as "experimental" in all respects, and indeed, whether the mode of innovation in evidence deserves to be called "experimental". However, if street pilots and urban demonstrations are not necessarily experimental, in the way that we would wish to understand the term, it does seem clear that these tests present a distinctive *innovation in the procedures of introducing technology to society*. Laboratory-based testing not on-the-road testing is today still considered the established paradigm in the automotive sector. In his

[1] With thanks to reviewer 1 for pointing me to this history of the computerized car: https://itstillruns.com/car-computer-history-5082250.html

[2] Intelligent Vehicles research at WMG, Warwick Manufacturing Group, video, 23 February 2017, http://www2.warwick.ac.uk/fac/sci/wmg/research/smarter/ For a playful presentation of the Volvo feature, see: Volvo S60 Pedestrian Detection System Test Failure, August 2010**,** https://www.youtube.com/watch?v=w2pwxv8rFkU

article 'From the Road to the Lab to Math' (2010), the organization studies scholar Paul Leonardi, on the basis of extended fieldwork in car companies, shows how over the course of the 20th century car safety and other forms of automotive testing like societal impact modelling have been increasingly confined to dedicated test sites and lab-based computer simulations. How, then, should we account for the fact that today automotive testing is being explicitly located in society, in everyday environments like the street?

In this chapter, I will examine the ways in which street tests of so-called intelligent automotive technology configure relations between innovation and society, and develop the argument that, notwithstanding some of the revolutionary ambitions pronounced in relation to the 'real-world testing' of autonomous driving, these tests *cannot* be understood in terms of the displacement of technology testing from the laboratory to society. This can become clear when we consider the 'networked' character of today's 'intelligent' car technology, which connects cars, if not exactly to the laboratory, then at least to data centres. More significantly, however, efforts to re-locate technology testing in 'real-world' environments must be considered incomplete, insofar as they facilitate only highly limited forms of social engagement and public participation in the evaluation of new technology. Through a discussion of recent street trials of intelligent automotive technology, I will propose that the testing of intelligent technology 'in society' today enable a double-edged operation upon existing arrangements for participation in the societal evaluation of new technology. On the one hand, such trials often are accompanied by explicit statements of commitment to participation. To test technology in everyday environments, amidst social complexity, makes possible a more active engagement with users, audiences and participants as part of the testing process than would be feasible in laboratory settings. And, indeed, a significant consequence of recent streets tests of intelligent cars is the curation of "environments of participation" in infrastructural environments in society. However, these trials can also be understood as contributing to the dismantling of existing mechanisms of public accountability of innovation. For one, these trials more often than not involve the use of public spaces by private agencies (Laurent and Tironi, 2015), and it is not self-evident what ensures the democratic legitimation of such partnerships. How then should we judge, and engage with, these double-edged, decidely ambivalent, implications of street trials of intelligent automotive technology for the relations between innovation and democracy ? To address this question, this chapter will discuss four different street tests of intelligent automotive technology: the roll-out of Autopilot by Tesla; an emission tests of a VW diesel car on the streets somewhere in Germany; the Gateway street trial in Greenwich (UK); and finally, an attempt by myself and colleagues to devise a street test of sorts of intelligent autonomotive technology in collaboration with colleagues, one using social research methods to conduct a participatory evaluation of driverless cars at the University of

Warwick. Before introducing these particular tests, however, I would like to say more about street tests as a format for the introduction of technology to society.

**2. Street testing as a mode of innovation: towards the beta-testing society?**

On-the-road testing of automotive technology resembles some other experimental formats for innovation in public or social environments, like the urban laboratory (Evans and Karvonen, 2014), living labs (Konig and Evans, 2013), and field experiments (Kelly, 2012). Deployed in different fields of research and innovation, from IT to sustainability and medical research, each of these approaches involve experimentation in everyday settings, away from scientific laboratories. In the words of Evans and Karvonen (2014), to experiment in social environments "is to create a space apart from the norm, and by bounding space, urban laboratories [..] inscribe a privileged space of innovation." (p. 415). The particular urban test that Evans and Karvonen describe here is a city corridor, a section of the Oxford Road in Manchester, which was designated a zone of low-carbon innovation by the municipal government around 2009, and was turned into a site for testing a variety of technologies, from air quality sensors embedded in pavements, to new road lay-outs, designed to favor pedestrians and cyclists over cars. This points to another distinctive feature of urban labs – or street tests: they do not only offer a site for technology testing, for trying out new or still unstable devices. Tests have a double function, presenting both a practical arrangement for trying out technical systems and an organizational space for configuring new forms of governance (See on this point also Leonardi, 2010). Thus, Evans and Karvonen characterize street tests as "a strategy for local governments" to pursue both economic and societal goals (sustainability, economic growth) "in partnership with public and private property owners" (p. 413). As noted above, Laurent and Tironi (2015) also highlight the capacity of street tests to assemble heterogeneous actors, and argue that they exemplify a negotiated form of governance based in partnership between government and industry.[3] Other scholars have emphasized that urban tests do not only operate in organizational and technical dimensions, but also in epistemological and mundane ones. Calvillo et al (2016) propose that urban experiments materialize an imagined future in which technology operates upon "the intimate details" of everyday life – from doing the laundry to the air we breathe (see also Wentland, 2016). Street experiments, then, create an 'in-between' space in which different types of actors come to interact – from companies to local government and mundane figures like "pedestrians" – and they operate in multiple registers, of innovation, politics, intimacy, imagination, and so on. By carving out bounded environments in society where existing or 'normal' relations and obligations may cease to apply, street tests allow for experimentation

[3] Importantly, tests have long been ascribed this relational capacity, irrespective of whether they take place in laboratories or in the field. In the case of automotive testing, Leonardi (2010) has described tests as a relational device for managing relations of accountability between government, industry and society. However, street tests bring social actors into play in a different way from laboratory tests, a point I elaborate below.

on the level of a) technology, through the implementation still unproven or unstable propositions, b) politics, by suspending established rules of public accountability; c) society, by attempting shifts in existing ways of doing things. As such, however, it is clear that real-world testing does not just enable participation with innovation, it may also undo forms of engagement that make up or made up 'life in the street.'

A distinctive feature of field tests, then, is their widespread uptake across a range of different areas of research, development, governance and activism – from social experiments in community cohesion to the piloting of new technical infrastructures, like responsive traffic light systems. Automotive technologies – cars – are then by no means the only innovations to be trialed by means of street testing. But over the last few years computationally-enhanced cars have featured prominently in media reports of on-the-road experimentation with technology. Most readers have probably heard of the fatal crash that occurred in Florida in the Spring of 2016 and involved a Tesla car in self-driving mode, which mistook an on-coming truck for the sky and killed its driver "while he was watching Harry Potter."[4] There have been other crashes, fatal and non-fatal, and many other more minor "kerfuffles" involving computationally-enhanced cars reported in the news in recent years. In July 2015, the Daily Mail asked the rhetorical question: "Is your car safe?", announcing that "Hackers had taken control of a Jeep Cherokee and crashed it into a ditch by gaining access through the entertainment system."[5] The article went on to report that The Cherokee "hackers" made their intervention "while sitting on a sofa" (although the same article also refers to these actors as "security experts"). One reason street tests of computerized cars have been at the center of public attention in recent years is no doubt the way in which different technological systems – and imaginaries, and industries, - intersect in the area of automotive innovation today. The development of what in the UK are called CAV's – connected and autonomous vehicles – explicitly crosses domains: it brings together the more traditional automotive industry (car companies) with newer players from the digital economy (the tech sector). Furthermore, these technologies are ascribed the capacity to address a broad range of issues from environmental health (reducing emissions) to economic regeneration (bringing new jobs to previously de-industrialized regions) (on this point, see also Marres, 2017). If it follows from the preceding discussion that *a distinguishing feature of field laboratories and street tests is that they enable the curation of an 'in-between space', cars today present an eminently suitable vehicle and object for the pursuit of such this strategic aim.*

[4] Levin, S and N Woolf, "Tesla driver killed while using autopilot was watching Harry Potter, witness says", The Guardian, July 1, 2016.
https://www.theguardian.com/technology/2016/jul/01/tesla-driver-killed-autopilot-self-driving-car-harry-potter
[5] Daniel Bates, The Mail Online July 22, 2015, http://www.dailymail.co.uk/news/article-3169724/Hackers-control-Jeep-Cherokee-crash-ditch-gaining-access-entertainment-amid-concerns-cars-vulnerable.html

There is a further reason why street trials of intelligent automotive technologies present an especially intriguing case for those concerned with the changing relations between technology, science, and society. As noted, automotive technology testing is or was supposedly firmly anchored in the laboratory: does the testing of technology in the street signal that the gap between laboratory and society is being bridged? I here would like to argue that today's "real-world tests" of driverless cars in everyday environments like public roads **cannot** be understood in terms of a straightforward re-location of experimentation from the laboratory to the street. Street tests do *not* simply involve the un-doing of Leonardi's (2010) historical narrative, which proposed that automotive testing had moved away from testing in 'the open road' to the closed spaces of the lab and 'virtual simulation' over the course of the 20th Century. While car testing is today being explicitly located in everyday environments like public roads, many of *these tests do not so much involve a move away from the lab, and this insofar as they bring "the laboratory' with them, into the streets*. Take this most well-known of cases from the area of connected and autonomous driving: Tesla's Autopilot, the driver-assist feature produced in the form of a software plugin directly downloadable into this fashionable brand of electric cars, which was released in 2014. It is in some ways the most well-known – or at least popular - of driverless street experiments today, with an estimated number of 100,000 vehicles participating by November 2016.[6] Importantly, this technology does not just facilitate automated driving, it equally involves location-based *data capture in the field:* as a reporter put it tellingly, Tesla uses 'its fleet of vehicles owned by its customers to collect data' and 'uses the data even when the Autopilot is not active in order to feed its machine learning system."[7] It may not be an exaggeration to say that the driver-assist application Autopilot is designed as much to establish new types of connections between data-capture in the field and analysis in the data centres managed by big tech companies, as it is to facilitate new forms of (automated) driving. And insofar as current street tests of intelligent automotive technology entail the re-validation of the 'open road' as a test environment, it is then of an 'open road' that is now intimately connected to, if not exactly the laboratory, to centers for data aggregation, crunching and algorithmic learning. *Street tests enable an expansion and intensification of interaction between the laboratory and the street, and* ***not*** *the displacement of innovation from the one to the other.*

Given this, it should not surprise us that various social, ethical and political problems have been pointed out with street testing as a way of configuring relations between innovation and society. It has been argued that urban laboratories are "simply 'dropped into' urban areas rather than integrated with their local contexts [..] with little regard for social issues"

[6] Lambert, F. (2016) Tesla has now 1.3 billion miles of Autopilot data going into its new self-driving program, Elektrek, 13 November https://electrek.co/2016/11/13/tesla-autopilot-billion-miles-data-self-driving-program/
[7] Lambert, F. (2016) Tesla has now 1.3 billion miles of Autopilot data going into its new self-driving program, Elektrek, 13 November. https://electrek.co/2016/11/13/tesla-autopilot-billion-miles-data-self-driving-program/

(Karvonen et al, citing Hodson and Marvin (2009), p. 415-416).[8] From this perspective, street testing is marked by a lack of engagement with societal contexts and concerns, and by a lack of accountability towards the populations enlisted in tests (see also Kelly, 2012; and Lindtner, 2015 on ethical problems with introducing relatively untested technologies into social environments). Street tests, then, may be valuable arrangements from the standpoint of innovation and governance, but it is far from self-evident they serve social and societal needs effectively. However, a very different way of understanding the relation between technology testing in societal settings and social issues is opened up by recent work by Steve Jackson and colleagues (2012). In their account, technology testing in everyday settings does not at all entail a disregard for social issues: to the contrary, it provides a way of rendering such issues amendable to an experimental approach. Jackson et al argue that, in the tech industry, it has become customary to release experimental products and services to users at an early stage in their development, as companies increasingly rely on user trials and field tests to identify *not only technical problems with the applications in question, but also ethical, social, political and legal problems with their functioning in society.* Such a **beta-testing approach to the introduction of new technology to society**, in their account, is "intensely relaxed" about releasing relatively un-tested, un-stable devices into everyday environments, and the societal disruption this may cause (see on this point also Stark and Neff, 2004). Indeed, it actively welcomes controversy, expressions of concern and outrage, insofar as this may be an effective way of cultivating an audience for a new product or service (see on this point also Geiger et al, 2014). Jackson and colleagues offer the example of a location-aware smart phone app called Girls Near Me: its release raised concern and indeed outrage online about the privacy and gender implications of the app. And this controversy translated into prompt changes in this application's design and functionality, offering the company an opportunity to demonstrate its willingness and capacity to "listen and learn." While the beta-testing of technology in society then provides opportunities to practice, and put on display, responsive governance, it also indicates a laissez-faire attitude towards harmful societal implications of technology: the suggestion is that such consequences must occur before they are addressable (Marres, 2017).

It is certainly *not* self-evident that street tests of intelligent automotive technology, as a general category, fit with Jackson et al's description of the beta-testing approach. It *does* appear to apply to the release of Tesla's Autopilot, in which case, too, an evidently unstable technology was being released into society, onto public roads. Here too, this was framed as an experimental opportunity to facilitate learning and product improvement (Stilgoe, 2017).

[8] Evans and Karvonen point out further problems: "A further issue regarding the corridor that has not been addressed is the unevenness of laboratorization; in short, the experimental capacities of cities are not distributed evenly (Hodson and Marvin, 2009) [..]This is particularly evident in the Oxford Road corridor, where adjacent low-income communities are being framed as beneficiaries of the infrastructure upgrades but not considered as participants in the experimental process. [..] " As such, the partnership and the laboratory tend to reinforce the divide between the knowledge community and the surrounding neighborhoods rather than integrate these." (p. 425-6)

Since its release, Autopilot has become the subject of a barrage of videos of accidents and near-misses involving Tesla cars in self-driving mode on YouTube (see Figure X),[9] which in turn have generated an avalanche of online commentary and news media reports, something which the company did not seem too interested to discourage. Following another, non-fatal crash involving a Tesla car in Pennsylvania in the summer of 2016, the company CEO Elon Musk repeatedly took to Twitter with provocative statements to the effect that "accidents happen".[10] However, Jackson et al's account is not straightforwardly transfer-able to other automotive street tests, such as for example those undertaken with government support in the UK, where the word "relaxed" does *not* adequately capture the significant caution with which these tests are being approached by industry and government – more about which below. The point then is: we need to empirically examine the different ways in which street tests of intelligent automotive technology configure relations between society, government and innovation in different contexts, and their adaptability to different normative objectives in this regard. Such tests seem to have both the capacity to facilitate societal engagement with new technology and to threaten or undermine existing arrangements of the evaluation of innovation from a societal perspective. Whether and how this ambivalence is exploited, exposed, ignored, rendered tractable, and/or addressed in street tests of intelligent automotive technlogy is what i will examine in the remainder of this chapter.[11]

**3. Emissions testing: intelligent cars as problems-of-accountability on wheels**

In the previous section I suggested that in the cause of Tesla's Autopilot, street testing was used to side-step the type of regulatory processes of evaluation that one would expect new technologies to undergo prior to their introduction to society. In this section, I would like to demonstrate that street tests not only generate problems of accountability, they may also be deployed to expose and address these very problems. I will do so by examining a by-now classic street test of a computationally enhanced vehicle. The on-the-road emissions tests that resulted in the VW emission rigging scandal otherwise known as Dieselgate were originally

[9] This is not a new genre, On YouTube, the video mentioned in footnote 2 has around 700K views and shows two guys trying to get the collision avoidance software on their Volvo cars to kick in, and failing, which apparently led Volvo more recently to cancel advertising campaigns publicizing said collision avoidance features in its higher-end models Volvo S60 Pedestrian Detection System Test Failure, August 2010**,** https://www.youtube.com/watch?v=w2pwxv8rFkU

[10] "The Tesla CEO responded to a second non-fatal crash involving the company's Model X vehicle in a Tweet explaining the driver's 'autopilot' feature was not engaged at the time of the crash. The company has faced controversy after a fatal crash in Florida in late May." Twitter moment, July 14, 2016 https://twitter.com/i/moments/753703538094505984?lang=en

[11] The ambivalence of technology – that it may serve both good and bad, legitimate and illegitmate purposes – is a well-established theme in the sociology of technology (Woolgar and Cooper, 1999). In societal testing of technology, this theme emerges anew, and, one could say, with a vengeance, as it here becomes caught up with issues of legal and indeed criminal liability for societal and environmental harm, as in the case of the emissions tests I discuss in the next section. I do not address this directly in this paper, but have argued elsewhere that there is no reason to suspend the notion of ambivalence in relation to criminal technology: while harm is rightly punish-able, this does not suspend the question of how it is to be defined and demonstrated. Marres, N. Evil artefacts have ambivalence too, 4S Conference, Barcelona, August 2017. See for a discussion Kelty, 2017.

undertaken by the Council for Clean Transportation of the University of West Virginia,[12] but an interesting variation on this trial has since then undertaken by two computing experts or hackers in Germany to highlight the role of software in the scandal. Two self-described "curious individuals", Felix Domke and Daniel Lange, a computer programmer and a former IT strategist of a large Bavarian car company, presented their findings of this trial in a public presentation to the Chaos Computer Club in Hamburg in December 2015. The object of their experiment was to demonstrate the workings of the "defeat device" - the piece of "cheating code" that was revealed in the summer of 2014 to be running on the *engine control boards* - ECUs - of an estimated 11 million of VW cars. This software is able to detect when the car in question is being driven under so-called 'test conditions' – by monitoring things like speed and the position of the steering wheel– in which case the ECU adjusts the car's performance, dramatically reducing its emissions of CO2 and cancerous NOX. When these artificial test conditions no longer apply, - that is, when the car is driving in the street and not in a lab - emissions radically go up. It was to expose this behaviour that Domke and Lange undertook their street trial: First, they purchased this particular ECU on Ebay. To demonstrate its workings, they then used a method called 'real-time logging': hooking the ECU up to his own car, Felix ran the firmware while driving around, first in his own neighbourhood, then on a so-called dyno in a garage. Monitoring the cars emissions over time, the defeat device can be seen to kick into action: when test conditions apply (slow, straight driving), the display shows reduced emissions. When moving out of this mode, emissions significantly increase.

It should first of all be noted that, in presenting their findings, Domke and Lange granted exceptional capacities to the "technological device," the Engine Control Unit and the firmware running on it, as the protagonist of the VW Dieselgate controversy. Their trial was designed to put the computational element in VW Diesel cars to an engineering test, and their test did not explicitly define the car as a social phenomenon (practice, infrastructure, system). Nevertheless, Domke and Lange's street test also has a number of designed features which enables it to inform societal evaluations of technology. Their test clearly was configured as a field demonstration, as an "experiment in society" - meaning in this case, that it relied on technologies and settings that are mundane, part of the fabric of everyday life, and generally accessible in society. As I said, they used Domke's own car; they purchased their ECU from the non-specialist platform Ebay; they ran the test driving in Domke's neighbourhood and then in a neighbourhood Garage; their "live logging" method made it possible to show how these cars go about defying regulations and damaging health as they go - "on the go," - by virtue of their "intelligent" ability to detect test conditions. Their street trial, one could say,

[12] Shiermeier, Q. (2015) The science behind the Volkswagen Emissions Scandal, Nature, 24 September 2015 http://www.nature.com/news/the-science-behind-the-volkswagen-emissions-scandal-1.18426

was designed as a way of keeping it real, of demonstrating the car's inner workings in the "real world," beyond the closed environment of the laboratory. As such, Domke and Lange managed to bring to life what to some might still seem a theoretical point: *it is in our streets, in the social environment, that VW diesel cars and defeat devices are wreaking havoc.* And this circumstance can be demonstrated in those very streets, using mundane technology. Domke and Lange, furthermore, also made a more abstract political point, about the problems of accountability that arise when software comes to mediate the relations between "the roads" - the infrastructural environments in society - and the laboratory - the more or less virtual tests sites and monitoring centres on which research and governance rely.[13] More specifically, they showed how the computerization of the car makes it possible to inscribe the test conditions (the laboratory) into automotive systems - the car "knew" when it was undergoing a test, and thereby was able to game it – and this seriously undermines the ability of government to regulate automotive behaviour in society by way of laboratory-based emissions testing. Cars may "change their behaviour without telling us."

More generally speaking, the introduction of intelligent automotive technology is intimately connected with efforts to computerize wider infrastructural arrangements in society – like automotive systems. These efforts are likely to give rise to new forms of interactivity between settings of everyday life and laboratories, or centres of management and control, and these forms of interactivity pose a challenge to laboratory-based forms of 'empirical governance.' Domke and Lange's street trial highlights some of these constraints placed on regulatory regimes in computationally intensive societies: the car's performance in the lab, may be strictly regulated, but its behaviour on the street is a different matter, and seems beyond the control of empirical forms of governance that are anchored in laboratory-based test regimes. And this problem accountability does not just pertain to the relation between government and industry, it equally implicates consumers and the wider public. However, there is also a sociological point to be made here, which received less attention in Domke and Lange's demonstration. In presenting their findings, these IT experts granted special capacities to technology, to the Engine Control Unit and the firmware running on it, but it is clear that the scandal cannot be solely attributed to these technologies. As Domke and Lange also pointed out, many experts and government insiders were aware of the existence of defeat devices in diesel cars by 2011 and the type of test results they presented had been known *for several years* by those familiar with the automotive industry (Lippert, 2016). It was only after sustained attention from journalists and other actors acting in the name of the public – including scientists and experts undertaking eminently reportable on-the-road emissions tests - that these "technical" results gained the capacity to cause a scandal. The public exposure of

[13] See CAVs the recent UK government consultation *Driverless vehicle testing facilities: call for evidence* issued by the Department for Business, Energy & Industrial Strategy and Innovate UK in April/May 2016.

the ECUs dodgy behaviour required extensive labour of interpretation by teams of scientists, policy experts, governmental agencies and NGOs (see Marres, 2016). The 'known' fact of emission rigging could only be proven to be unacceptable on a societal level. The passage of Dieselgate through everyday conversation, just as the passage of the toxic NOX through our lungs and bodies, were critical to achieving this scandal. Accordingly, we may define *the street trial as an interface between innovation, industry, government, society and the public - a site that allows for mutual engagement between sectors, but where, at the same time, a crisis of accountability can become detectable.*

4. **Self-driving cars: changing relations between the lab and the street, and the public**

Recent street tests involving driverless cars, or as they are known in the UK, Connected and Autonomous Vehicles (CAVs), could be said to take these questions of accountability to the next level. Whereas in the VW emissions scandal the limited reach of regulatory frameworks features as a matter of concern, and indeed, scandal, in the case of CAVs the limits of existing regulatory regimes have been publically affirmed as given. While the UK government has adopted a code of practice for the real-world testing of CAVs,[14] many regulatory aspects remain under-explored. Alongside its code of practice, the UK government has endorsed what it called in its 2016 evidence check "a non-regulatory approach" to connected and automonous vehicles,[15] an approach that celebrates the uniqueness of the UK as the only country in the world in which it is legal to take your hands off the steering wheel while driving on public roads, meaning that there is no need to go through a formal approval process to test driverless cars. There are currently several street trials underway in UK cities, and these trials range from widely publicized corporate street tests undertaken with direct government support, as in the case of the driverless pods currently being tested on selected public roads in Milton Keynes and in London's industrial North Greenwich quarter,[16] to more small-scale tests in London with so-called "non-descript mules" – "an industry term for a car that has the technical components of a future model, [but] doesn't necessarily have the production exterior components," and are thus likely to go unnoticed.[17] Driverless cars are also set to arrive in the city of Coventry, where I currently work, although at the time of writing it is still uncertain in what form.[18]

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[14] https://www.gov.uk/government/publications/automated-vehicle-technologies-testing-code-of-practice

[15] Driverless Cars Evidence Check, Science & Technology Select Committee, April 2016, https://www.parliament.uk/documents/commons-committees/science-technology/evidence-tests/Driverless-cars.pdf

[16] http://londonist.com/2016/01/driverless-pods-are-coming-to-greenwich; http://www.digitaltrends.com/cool-tech/london-testing-driverless-public-transportation-pods/

[17] http://mashable.com/2016/06/22/faraday-future-driverless-car-license-california/?utm_medium=twitter&utm_source=twitterfeed#jJkkU.bZZiqR

[18] "Driverless cars are coming to the streets of Coventry in 2017" http://www.coventrytelegraph.net/news/coventry-news/driverless-cars-coming-streets-coventry-10814799

However, it is already clear that in this non-regulatory context, the introduction of driverless cars affects relations not just between the laboratory and the street, but also between the laboratory and the street and the public. These relations are multi-faceted. On the one hand, the first reports are in of public protests against driverless cars in the UK, as cyclists criticize municipal governments for trialling "driverless motorcars [..] on pavements while cyclists were regularly vilified for pedalling on them."[19] On the other hand, street trials currently happening in Greenwich and Bristol come with extensive provisions for public participation. As the homepage of the current Gateway Trial in Greenwich loudly summons: "GET INVOLVED". Its "September Update" reports: "In May we opened the door for members of public to register take part in the Gateway project. Since then over 5,000 people have registered for a chance to take part which really demonstrates the enthusiasm and interest in automated vehicles." Several of these participation initiatives have a distinctively experimental flavour as in the case of the locative opinion mapping exercise undertaken by digital agency common place in Greenwich, which invites Greenwich residents to report their views on driverless cars in a location-specific way, by annotating a Greenwich map (see Figure X).[20] In line with this, it is also clear that participation exercises in Greenwich are undertaken with a research-led framework. The stated aim is to "gain insight into people's attitudes towards the use of automated vehicles and their operation in cities."[21] As such, these initiatives are in line with Javier Lezaun and Linda Soneryd (2007) account of public participation exercises as forms of knowledge-production: governmental initiatives to foster public engagement with innovation, they note, often double as social research. The production of data and expertise demonstrating "levels of societal acceptance" of new technology is as important an object as the facilitation of public engagement itself. What is striking about the UK context, is how relaxed the organizers appear to be about publically endorsing this instrumental approach to public participation in street trials. If there are any tensions between the roles of citizen, tech enthusiast and research subject in street trials, they are not considered to pose any trouble.

Arguably, a rather paternalistic logic of participation appears to be at work in some of the recent UK trials, as when these trials are explicitly framed as instruments for "increasing public acceptance." As a representative of the Transport Catapult that organised a recent demonstration of driverless pods in Milton Keynes explained the rationale behind public street trials: "A lot of it is about gaining the trust of the public. If people can see that these vehicles are capable of driving themselves, they can gain trust and make sure that all the

[19] Loeb, J. (2017) Pedestrians rage at autonomous pods and delivery bots on pavements, July 6, 2017 https://eandt.theiet.org/content/articles/2017/07/pedestrians-rage-at-autonomous-pods-and-delivery-bots-on-pavements/

[20] With thanks to Jimmy Tidey for pointing this out to me.

[21] Gateway, Project Update, September 2016, https://gateway-project.org.uk/project-update-september-2016/

correct safety measures are in place to allow them to drive themselves, *and then that is exactly what we should be doing* (italics mine)."[22] These are rather managed events. Reports of this LUTZ pathfinder trial in Milton Keynes were under embargo until the day *after* this street test took place: it appears that publics are only allowed to engage qua publics after the fact. It suggests that street trials in the UK are certainly *not* in all respects conducted in the beta-testing spirit identified by Jackson and colleagues: it is *not* the case that social, ethical and legal problems are allowed to freely emerge, 'in the wild.' Rather, participation initiatives appear to be designed to achieve particular pre-determined operations upon public perceptions of intelligent automotive technology.

This raises a further question: to what extend do these street tests of driverless cars satisfy the definition of an experiment, where their social and public dimensions are concerned? Javier Lezaun, Manuel Tironi and myself (2017) have written elsewhere about 'experiments in participation' which we define as "the deployment of settings, devices and things to curate processes and moments of participation in which, under at least partly controlled conditions, taken-for-granted ways of doing are unsettled, and which elicit expressions of public affairs that would otherwise remain under-articulated or exist only *in potentia* (Lezaun, Marres & Tironi, 2016)." Considering driverless street trials from this perspective, it can seem that fairly little is put the test in these events, at least not where the social aspects of driverless cars – their capacity to operate in society - are concerned. In view of the framing of these trials as instruments for increasing public acceptance of this technology, it can seem that very little can happen here, in the sense of the curation of a situation in which a proposition can be challenged, or new perspectives can emerge. There can seem to be little attempt at problem articulation**.** However, such an analysis should be considered incomplete or even lazy, insofar as it only considers the public media framings of these trials. I want to probe further to see what experiments in participation, exactly, *can be* enabled through street tests of driverless cars.

## 5. Experiments in interpretation: Eliciting social aspects of driverless cars in the West Midlands

To explore this, my colleagues and I have been developing street tests of our own, with the specific purpose of eliciting social aspects of driverless cars.[23] In this research, we used a range of creative methods - including digital methods of issue mapping (Rogers and Marres, 2001) and practice-based approaches to design research (Kimbell, 2009) - in order to analyse

[22] https://www.theguardian.com/technology/2016/oct/11/self-driving-car-first-uk-test-milton-keynes-driverless-lutz-pathfinder

[23] With thanks to Nerea Calvillo, Rebecca Cain, Ana Gross, Lucy Kimbell, Alessandro Brunetti, James Tripp and Arun Ulahannan. For more info see the workshop report "Surfacing Social Aspects of Driverless Cars with Creative Methods", University of Warwick, April 2017 http://www2.warwick.ac.uk/fac/cross_fac/cim/events/driverlesscarswithcreativemethods/

and enable conversations about driverless cars. During a post-graduate workshop at Warwick in September 2016, we ran an initial test, in which we mapped issues raised by driverless cars in social media in a location-aware way, focusing in the West Midlands, the region where I work and where driverless cars have been said to be arriving soon.[24] This exercise focused on a specific platform, namely Twitter, where much publicity around driverless cars occurs. We asked: Can we use social media analysis, not to conclusively represent the debate, but as a heuristic for identifying issues raised by driverless cars in our region? We delineated a particular Twitter data set with the aid of the Twitter Toolset for the Capture and Analysis (T-CAT), consisting of of all tweets containing the term driverless – and similar terms like self-driving, autonomous vehicle, CAV - during June and September 2016.[25] For the purposes of this exercise, we included only the tweets traceable to the region, namely tweets sent from accounts that listed Coventry, Warwick and other locations in this region. We then asked: What issues do driverless cars raise across locations in this region? To answer the question, we manually extracted issue terms from the data using a loose interpretative framework, which we then visualised using different criteria such as uniqueness and frequency (see Figure X). In doing so, our aim was *not* to produce a conclusive representation of the issues, but rather, to produce issue maps that could subsequently be deployed as "devices of elicitation" (Lezaun and Soneryd, 2007): displaying concerns offers a way to elicit views during informal encounters in the street and other social settings, such as the Warwick Campus café and Coventry city centre, inviting actors to informally account for issue formations.

The issue visualisations we produced in this way, I think, do demonstrate a capacity of UK street trials to elicit social aspects of driverless cars. The issue terms that made it onto our maps display a broad range of concerns - from "mobile living room for shopping" to "how does it feel?", "lethal robots," "new types of testing needed" and "divided industries" (Figure X) – especially the conjunction of such specific heterogeneous terms suggests more is going on than either the promotion or rejection of known proposition, i.e. issue formation. However, for these expressions to qualify as issue *articulations* more is required than their visualisation in a map. To gauge the salience of these formations, further operations are required. To this end, we made an attempt during a second workshop to curate an environment for the exploration of issue-scapes: together with Rebecca Cain and others of the Warwick Manufacturing Group, we organised a creative participation exercise, inside the aforementioned driver-in-the-loop simulator, in which we invited participants to annotate the simulator, using issue terms featured in our social media maps. Participants received

[24] Driverless cars coming to the streets of Coventry in 2017, Simon Gilbert, 1 February 2016 http://www.coventrytelegraph.net/news/video-driverless-cars-coming-streets-10817021

[25] We used T-CAT, the Twitter Toolset for the Capture and Anlysis of Twitter data, developed by Erik Borra, Bernhard Rieder and others (Borra and Rieder, 2014).

instructions as to how to produce an issue scape by annotating the simulator, using sticky notes to mark up objects present in the simulator – like the car itself, or the stretch of Coventry road projected on the 360 screen surrounding them (Figure X). There were also cardboard figures available for annotation, representing human actors and cardboard boxes representing non-humans (machines; technologies; institutions; etc.). While participants were clearly fascinated by the simulator itself, they also made significant efforts to locate some of the issues mentioned on social media in the driverless simulator environment – in doing so generating further issue articulations. For example, 'the elderly' were introduced in the setting in the form of an 'old lady' cardboard figure, which was settled into the back seat of the car, with a note on the window noting 'a dashboard that says 'old lady on board': stigma'.

The design of these social tests of driverless cars is currently on-going, but it is already clear that these exercises are decidedly interpretative in nature: the objective is not to document concerns as they 'naturally' exist out there, in society, but rather, to determine how existing experimental settings – like the social media platform Twitter, or the driver-in-the-loop simulated at the University of Warwick – can be configured to enable the collective articulation of social issues in an interpretative register. In both cases, the researchers addressed and actively involved others – passers-by in the street, in the first exercise, invited workshop participants from government, academia and the non-governmental sector, in the second – to explicate and elaborate issues associated with driverless cars. As such, they implement part of the definition of an experiment in participation mentioned above, namely to generate a form of engagement that did not already exist prior to the research. However, even as both these exercises aimed to move beyond a descriptive or 'representational' approach to researching public perceptions of technology, the aim is certainly not to replace this with an narrow interventionist, or actionist understanding of participation. Participation can*not* be adequately understood as phenomena that can be straightforwardly 'created' or 'designed' (Marres, Wilkie and Guggenheim, forthcoming). Instead the point is to generate interpretations of an exploratory kind, or better put, to explicate issues raised by driverless cars that are latent in the setting. This is why a generative test environment is all important to the success of the exercise, and also why the term 'experiment in interpretation' might be more appropriate in this instance. In a context in which participation is decidedly ambivalent from a normative perspective – being so eminently deployable to multiple, even contradictory, ends - this seems to be an especially important question: has the test produced a situation in which new qualifications of the phenomenon in question can be produced? Does it enable experiments in interpretation (Marres, 2016)?

## 6. Conclusion

Research on the social capacities of driverless cars is in its early stages, and it is certainly too early to draw any conclusions about the type of issue formations that driverless street trials are eliciting or could elicit in the UK context. But some more speculative conclusions about the role of street trials as devices for the societal introduction of intelligent automotive technology can be drawn. Firstly, and most importantly, there can be little doubt that street trials do not just serve to test to technical aspects of intelligent automotive technologies, they also enable the evaluation of their functioning in society. More specifically, street tests of these innovations involve the configuration of "environments of participation" in society. I have argued that the operations upon participation that these tests enable are decidedly ambivalent: while intelligent technology tests in social environments like public roads offer opportunities for, and indeed necessarily include, public and societal engagement with the evaluation of new technology, they also enable the side-stepping existing arrangements for the public accountability of new technology. Under these conditions, it becomes important to determine whether and to what extend street tests have the demonstrable capacity to facilitate issue articulation. I have proposed that driverless street tests are and can be configured to enable the elicitation of social, political and ethical aspects of new technology that are not already apparent, but that they are *not* on the whole already configured this. The explication of social and societal dimension of inteligent technology requires the deliberate adaptation of test environments in society to enable participatory forms of evaluating innovation and societal change.

Ann Kelly (2012) has proposed a very useful term to characterize the forms of participation enabled through field experiments: in her study of experimental huts used in malaria research in the Gambia, she proposes that fields experiments involve the curation of a "semi-field" (Kelly, 2012), a “controlled yet un-contained setting” [..] [which] “fuses a generic scientific space and a specific inhabited space.” (p.  6 - check). And: these experiments happen in the field but aren’t ‘of the field’ (Kelly, pers. Communication). Similarly, the street tests of intelligent cars that I have discussed in this chapter involve the construction of a location between laboratory and society that is artificial enough for the functioning of technology to be controll-able and manage-able, while "natural enough" for social engagement with technology to become possible in these settings (see also Derksen and Beaulieu, 2011). It is this ‘semi-naturalism’ of field experiments that will be crucial to recognize in further investigations - and tests - of the evaluative capacities of street tests, of their ability to serve as instruments for the evaluation of not just hte technical but also the social, cultural and political aspects of the introduction of intelligent technology to society. While urban tests, social experiments and field laboratories feature prominently in societal programmes for the introduction of new technology to society, these forms of engagements are generally

understood as *complementary* to regulatory approval processes. Rightly so. Nevertheless, the role of technology testing in society has radically expanded over the last years, assuming a prominent role in the public communication of innovation, and as part of strategies for promoting 'societal acceptance' of technology. Tests, experiments and social laboratories increasingly function as de facto conditions for public engagement with innovation, and as such, it becomes crucial to move beyond external assessments of their legitimacy. We must also step 'inside the bubble' to undertake internal tests of their generative capacities: are street trials able to facilitate the evaluation of innovation from a societal point of view?

If we consider the ways in which street testing configures infrastructural environments in society – or are deployed to that end - it can seem plausible, from a sociological or philosophical perspective, to interpret these tests *as threats to democracy, and/or the culture of public accountability*: the experimental introduction of new automotive technologies into society then presents itself as a vector of the commercialization, privatization and managerial-ization of public space (for a discussion of this point, see also Dickel, this volume). To adopt such a critical frame of interpretation is to think along with Hannah Arendt (1958), for whom the rise of the technological society amounts to the dis-organization of the public realm, understood as a space for political action. From this perspective, street trials signal the empty-ing out of the spaces of public action, and political accountability, and the invasion of "administration." However, in this chapter I have tried to show that this "threat" does not adequately sum up driverless street trials, as they are configur-able to serve other purposes. Street experiments can be criticized for many reasons, but it *cannot* be said that they inherently lack of capacity for problem articulation. If we consider the range of issues that street trials elicit, from stigmatization to securitization, and it is clear the insights generated in these experimental settings have freshness and relevance for multiple audiences. One indication of this is the range of entities that were invoked in the experiment in interpretation we undertook in the driver-in-the-loop simulator: road kill, the visually impaired, Brexit, industrial regeneration, new trends in road rage, and so on. It is not enough, then, to determine whether street tests do or do not satisfy requirements of participation and accountability from an external perspective. The question is also whether the methodology and design of street tests of intelligent technology are configure-able so as to facilitate experiments in participation: the challenge is not only to 'interpret' the role of technology testing in society but to specify requirements for the adjustment of this role to the task of societal evaluation. This indicated yet another way in which street trials are decidely double-edged: on the one hand, disparate entities are brought into relation through these exercises, in ways that contribute to the elucidation of the societal challenges involved. On the other hand, this process of catelogueing the entities and concers involved also highlights the extend of

their misalignment, the immense challenge of bringing them together into a shared frame that could accord them a degree of commensurability.

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