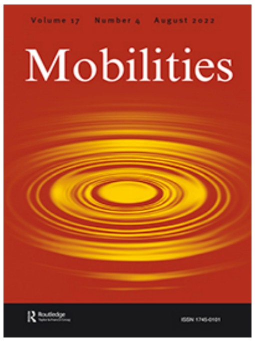

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Making decisions: the normal interventions of Nissan 'mobility managers'

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ABSTRACT
In this article I investigate a decentralized infrastructure meant to assist autonomous vehicles in making decisions. More akin to a call centre than a centralized control room, Nissan's 'Seamless Autonomous Mobility' (SAM) project imagines that remote 'mobility managers' will intervene in the decision-making of autonomous vehicles, with the assistance of live video streams and other sensor data. Different from other kinds of AI microwork in which human workers prepare, imitate, or verify AI, mobility managers are envisioned instead as 'interveners', meant to directly and actively intervene in the movements of 'autonomous' vehicles when unable to negotiate an obstacle. Firstly, through a comparison between SAM and a traffic management system in Los Angeles, I argue that the former 'normalizes' intervention, in which decision-making delays become ordinary, if not altogether desirable. Secondly, through an analysis of a video in which such normalized interventions are imagined, I consider how SAM offers a kind of speculative mundanity in which remote workers, enabled by a technological infrastructure, embody a novel logic that modifies the social settings of driving.

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Introduction

A shirted man sits in a darkened room, presiding over a widescreen display showing multiple live feeds from an electric, and ostensibly autonomous, Nissan Leaf. Accompanying the live feeds is what appears to be a satellite image of an urban environment. Overlaying the blurry satellite backdrop is a series of parallel yellow lines, bent to follow the path of a road. Scattered in the vicinity are a collection of multi-coloured dots, forming a spectral outline of nearby fences, benign street furniture, and other unknown, but possibly problematic, obstacles in the road itself. The man is shown using an elegant, wireless computer mouse atop a gleaming, uncluttered surface. With each careful click of the mouse, a new cyan-coloured dot appears on the screen in front of him. With each subsequent dot, a neat line extends further, protruding from an avatar of the vehicle on the same screen. Upon drawing the line, the real-world Nissan Leaf proceeds to steer around a mysterious cluster of the multi-coloured dots: a line of traffic cones around a vehicle being unloaded.

The aim of this article is to investigate Nissan's Seamless Autonomous Mobility (SAM) project, described above, that promises 'ultimate … intelligent integration' (Nissan 2017b, n.p.) between a nominally autonomous vehicle, and a wider infrastructure capable of intervening in the decision-making of the vehicle itself. The article will consider how Nissan envisions the project as a way to 'realize a fully autonomous future' (Nissan 2019, n.p.), whilst ensuring human actors are primed to intervene 'at a distance' (Sprenger and Vagt 2020, X) should things go wrong. In this, Nissan is eschewing algorithmic narratives like others, such as Uber ATG (Advanced Technologies Group), who

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see software as key to an autonomous future (Shetty 2020), or HERE, who consider 'self-healing maps' as critical (HERE 2017). The difference with Nissan's alternative 'mobile utopia' (López-Galviz, Büscher, and Freudendal-Pederson 2020), however, is not simply that its own vision actively centres human involvement. Instead, that it results in the normalization of remote intervention in which drivers come to accept momentary delays (Farman 2019), as they wait (Bissell 2007) for assistance, in return for an enhanced driving experience in which they themselves are freed from making decisions. This despite the belief that such a project is intended to yield an entirely 'seamless', machine-learning driven, 'instant' future.

I begin by discussing the significance of competing imaginaries, from logistical 'nightmares' (Rossiter 2016) to dreams of automation (Bassett and Roberts 2020) and the 'technological sublime' (Hildebrand 2019). I contend that Nissan's SAM project offers a kind of 'speculative mundanity' in which the normalcy of human intervention 'on the ground' is not only accepted but celebrated. In short, the opposite of so-called 'ghostwork' (Gray and Suri 2019) in which AI-related human labour is hidden from view. This technological speculation (Hong 2020) is embodied in the figure of the 'mobility manager' who is primed to (speculatively) intervene in (mundane) driving situations that exceed the decision-making capacities of an autonomous vehicle. Such an epistemological framework governs the aspirational interventions made by mobility managers who demonstrate a new logic of testing (Marres and Stark 2020) operating *on*, rather than merely *in*, the social life of driving (Brown and Laurier 2017; Laurier 2019) through their precise, yet mundane interventions, thus reconstituting driving (as a series of established practices), and the road (as a particular social space).

That they are referred to as managers suggests that Nissan sees their role not as mere content moderators (Gillespie 2018), or as low-skilled digital workers (Irani 2013). At first glance, mobility managers look like both: sitting in front of a computer screen, viewing, and approving visual 'content', performing intermittent tasks. Yet their role is also subtly different, as they make sense of the stream of 'operative images' (Farocki 2004; Hoel 2018; Distelmayer 2018) transmitted from the vehicle. Thus, I contend, that Nissan is positing an alternative vision of AI-oriented human labour, in which typical categories of AI preparation, imitation, and verification do not necessarily apply (Tubaro, Casilli, and Coville 2020). In this I offer an additional figure of the 'intervener', in which human actors directly, and actively, intervene in the movements of 'autonomous' vehicles, with the assistance of live video streams and other sensor data, through which vehicles are expected to learn from, and copy, in order to navigate similar, future situations.[1]

To understand this interventionism, I begin with a two-fold comparison with Hayles (2017). Firstly, I consider the limitations of 'cognitive assemblages' (Hayles 2017) in which cognition is distributed between humans and technical objects. Instead, I offer an alternative approach starting with the decision, which enrols cognition as a part of, but not a precursor to, decision-making. In this, I consider the interventions intended to be made by mobility managers as examples of scripted practices, rather than strictly cognitive processes. Secondly, I distinguish between Los Angeles' (LA) Automated Traffic Surveillance and Control System (ATSAC) discussed by Hayles, and Nissan's SAM project. Whilst these systems do similar things – providing infrastructural support for the execution of decisions affecting automotive transportation – ATSAC only manages *traffic* (Vehlken 2020; Wagenknecht 2020). In contrast, SAM monitors and intervenes in the *vehicle* itself. Whilst the latter may appear to be a classic transportation control room (Luque-Ayala and Marvin 2016; Boersma 2018, 2020), operationally, it shares greater similarities with call centres and other spaces in which AI image-related work is performed.

In the final two sections I analyze a video produced by Nissan on the SAM project, demonstrating how these 'normal' interventions are imagined by Nissan in the negotiation of obstacles, such as temporary roadworks or a van being unloaded. Having originally encountered the project at the 2018 Geneva International Motor Show (GIMS), the video provides a distillation of their interventionist vision. In this, I argue that Nissan aspires to offer 'in the wild' (Hutchins 1995) intervention by mobility managers, normalizing a new kind of 'automotive microwork' meant to radically transform the practice of driving.

Envisioning the future of driving

Sublime automation

For Bassett and Roberts (2020, 14), 'dreams (or nightmares) concerning automation' in the mid-20th century 'were based more on an idea than a functioning reality'. By the 1960s, despite the relative paucity of computers in the US, and their concentration in the hands of the US military:

> . . . the *idea* of automation as a serious proposition, inspired in part by cybernetic claims of general systematisation, had taken root, in social and political milieus, and for those participating in the construction and circulation of this imaginary, it *was* qualitatively distinct from mechanisation' (14, authors' emphasis)

Thus, the dreams (and nightmares) of automation were starting to have a life of their own. Rather than a straightforward continuation, or intensification, of the mechanization of industrial processes – as some definitions of automation conceived it – the automation imaginary was conjuring up something more distinct. Through these dreams, automation was something that would, or could, happen beyond the factory floor, with wider societal effects outside the factory door. Here, automation involved not only the freeing of hands from arduous production processes, or even the freeing of bodies from menial 'clerical and bureaucratic tasks' (14), but the freeing of minds from labour, and principally, *decisions*, altogether.

As Bassett and Roberts (2020, 22) conclude, 'automation debates not only reflect chronologies of technical development' but also 'run ahead of them'. Thus I am principally interested in how the 'technological imagination' (23), or Nissan's dreams of distributing decision-making tasks to human operators 'travel in different ways, and more relatively autonomously, from the many material forms in which it may be partly instantiated, than might be expected' (23). In other words, to consider why Nissan might at all be offering its own version of the 'infrastructural ideal' (Manderscheid 2014, 613).

Here I suggest that these distributed dreams are akin to a technological utopia, or what Rossiter describes as the 'logistical imaginary of seamless interoperability' (Rossiter 2016, n.p.). Whilst the Nissan project I wish to focus on is not a logistical system, per se, it is nonetheless driven by a similar motive: an imagined future in which images, sensor data, tasks, decisions, and algorithmic updates all seamlessly flow, in a vision of 'vascular circulation' (Usher 2014, 554), from one place to another. Here, dreams are, more precisely, designs or plans 'running ahead' of the proposed development of a future product intended to manage, and distribute, vehicle control. As an example of the 'securing of circulation' (O'Grady 2014, 514) the project can be seen to offer an idealized sovereign vision through which automotive 'circulation, in the very broad sense of movement, exchange and contact' (Foucault 2007, 64) is controlled.

Nissan maintains what it refers to as a 'technology archive' (Nissan 2020). Available online, the archive records active projects at the company according to three categories: car technologies (such as 'High Beam Assist' or 'Lane Departure Warning'), future technologies (in-wheel motors, wireless charging systems etc.) and concepts (vehicle to home electricity supply systems etc.). The projects are largely categorized based on their readiness, with most of the entries in the car technologies section already integrated into Nissan models. Whilst entries into the future technologies and concepts categories might not necessarily be precursors to future products, they constitute socio-technical realities in their own right, 'running ahead' of any market-ready systems, positioning Nissan as a forward-thinking company with an imaginative, and innovative, research and development (R&D) programme.

Nonetheless, there are perhaps two intersecting 'chronologies of technical development' concerning autonomous vehicles. Firstly, the development of systems offering driver 'assistance', in which 'autonomous' control is only made possible in discrete situations such as driving on a motorway (BMW 2020), or for specific tasks, such as parking (Volvo 2019). Building on the long, incremental history of assistive technologies such as power steering or anti-lock brakes (Thrift 2004), they are increasingly offered by car manufacturers as a standard feature, such as those by Nissan mentioned above, rather than as optional extras. Intended to supplement, rather than replace, human control, more complex driving scenarios such as navigating roadworks, or driving in urban areas, are typically not dealt with by such assistive technologies.

Secondly, a more recent history, in which 'fully autonomous' vehicles offer wholesale control by a vehicle system in a wide array of situations. Here, human control is still technically possible, but the vehicle system itself has responsibility for sensing the environment and reacting appropriately to possible hazards. Typically being developed by 'big tech' companies including Uber ATG (Levin and Wong 2018) and Waymo (Hawkins 2018), and more recently by Argo AI (Korosec 2020) and Aurora (Schiffer 2020), these technologies are largely driven by machine learning algorithms and software (Bialski 2020), based on a combination of real-world tests and virtual modelling (Hopkins and Schwanen 2018; Stilgoe 2019; Marres 2020). In this category, the autonomous vehicle is expected to tackle anything unexpected, using its sensing capacities enabled through a varied assemblage of cameras, lidar, radar, and object-recognition software.

Both developmental trajectories 'draw on the visual rhetoric of the sublime' to 'promote idealist "predefined ends" of self-driving automobility' (Hildebrand 2019, 155–156). This socio-technical imaginary plays a significant role in shaping the path of automobility itself, willing certain futures into being. Likewise, Wigley and Rose (2020) contend that various 'visions' structure development trajectories, or 'how CAVs [Connected and Autonomous Vehicles] are visualized as future mobilities' (5). The effect of these technological visions is that novel driving experiences, and with them, entirely new driving identities are cultivated.

Mundane modification

In the following I argue that some of these imaginaries – such as Nissan's SAM project – are necessarily more speculative than others. Less concerned with establishing a roadmap to a future state, such visions are framed as exercises in R&D, aping scientific nomenclature and established styles of communication. In Nissan's case such a framing goes a step further: involving NASA in the development and publicity of SAM. As coordinators of the Apollo space program (1961–1972), NASA embodies the 'heroic … moonshot' (Haigh 2019, 30) attitude that Silicon Valley often seeks to emulate. Yet the project itself is more a case of speculative mundanity: of a routine future governed not by all-seeing sensors, or all-knowing algorithms, but embodied in the rote, repetitive work of a mobility manager engaged in critical decision-making so drivers are freed from it.

I contend that the idealized intervention of mobility managers is an example of a new logic of testing (Marres and Stark 2020), such that the social life of driving (Brown and Laurier 2017; Laurier 2019) is envisioned as being actively intervenable in with the help of a decentralized architecture, and the proliferation of sensors and devices able to capture and transmit data to remote operators. Within the automotive industry it is Nissan that best typifies this interventionism, in which narratives of algorithmic omnipotence or the dominance of AI are tempered. The logic of this interventionism consists of 'testing the settings' (Marres and Stark 2020, 435), in which remote operators are envisaged to be able to intervene in driving itself, by tweaking the response of a vehicle to particular kinds of situations. Here, such 'testing operates *on* social life, through the modification of its settings' (435), to 'inform, inflect, or influence the social phenomena that unfold within' (436). Whilst such a logic has arguably already been tested in other social settings, such as with Facebook's infamous 'emotional contagion' study (Kramer, Guillory, and Hancock 2014; Hallinan, Brubaker, and Fiesler 2019), it takes on a new, even riskier form when deployed within an automotive setting. Indeed, that rather than merely 'suggesting' or 'nudging' individuals within particular social contexts, the logic goes a step further to also offer purposeful, direct intervention into how driving is performed, modifying both game rules (settings) and gameplay (actions), so to speak.

The speculative mundanity of the distributed decision-making discussed in this article is both *mundane* for the way it intervenes in everyday driving situations, disrupting the 'microdecisions' (Sprenger 2015) made by an imagined autonomous vehicle under normal circumstances, but also *speculative* because of the ambitious attempts to modify the social settings of driving, by taking remote control of autonomous vehicles in order to guide them around obstacles. As Marres and Stark (2020, 436, authors' emphasis) continue:

> . . . the operations that produce today's total test environment consist of minor modifications in the environments in society so as to render *the setting capable of data capture, analysis, and feed-back* – that is, to equip it as a test environment, to enable representation *and* intervention – even if aspirationally – on a more or less durable basis.

The envisioned development of SAM, based on technology used by NASA to explore lunar environments, is an extension of this 'total test' mentality – or at least, its aspiration, in which every captured action enables the testing of settings, and provides the conditions for active intervention. Facilitated through a decentralized architecture of call centre-style workplaces, the interventions are themselves distributed to specific, available decision-making individuals who then, ideally, see their decisions *re-distributed* throughout a connected vehicle manufacturer network to enhance the future decision-making capacities of similar vehicles. In short, the article considers how the *envisioning* of driving in the future is *enacted* through the scripting of novel interventions.

Distributed decision-making, and 'normal' intervention

Nissan's SAM project is not a sensor system, nor a standalone vehicle platform, but a decentralized infrastructure enabling the distributed monitoring of, and intervention into, autonomous vehicles manufactured by Nissan. In this, the autonomous aspect – that of the automation of decision-making and action – is part of a larger architecture deliberately involving human operators. The higher order dream of distributed decision-making gives way to a lower order sensibility in which mobility managers draw virtual paths for Nissan vehicles to avoid obstacles. Here, Nissan keeps humans 'in the loop' (Gray and Suri 2019; Taylor and De Leeuw 2020), creating what I refer to as interveners, that exceed Tubaro, Casilli, and Coville (2020) threefold categorization of platform-related AI microwork, of AI preparation (performed by 'trainers'), AI impersonation ('imitators'), and AI verification ('verifiers'). In such AI-related work, interveners actively intervene in situations that cannot be negotiated by autonomous vehicles on their own.

In doing so, they perform a similar role to trainers preparing AI for work 'in the wild' (Hutchins 1995). Except, that is, that such interventions are themselves intended to be performed in the wild, on real-life roads, and in real-world situations. As SAM arguably complicates the two automotive chronologies outlined previously (driver assist, full autonomy), I want to make a comparison to a specific traffic management system discussed by Hayles (2017) that serves as an infrastructural antecedent of sorts to SAM in the way it seeks to manage, and control, traffic.

Traffic management as cognitive assemblage

Closely related to the idea of distributed cognition (Hutchins 1995) or distributed activity (Turner et al. 2006) is what Hayles (2017) refers to as 'cognitive assemblages'. In this, Hayles desires to 'expand the spectrum of decision makers to include all biological life-forms and many technical systems' (115):

> While a cognitive assemblages may include material agents and forces (and almost always does so), it is the cognizers within the assemblage that enlist these affordances and direct their powers to act in complex situations. (116)

In this, a 'cognitive assemblage emphasizes the flow of information through a system and the choices and decisions that create, modify, and interpret the flow' (116). Thus, Hayles is interested in articulating how cognition operates, and how an 'assemblage' formats this cognitive power. What is important for Hayles is that the definition of cognition is expanded beyond the human, and beyond consciousness itself. Through the cognitive assemblage Hayles focuses on how ‘power is created, transformed, distributed, and exercised in an era when complex human systems are interpenetrated by technical cognition’ (117), in which cognition is conceived as a ‘process that interprets information within contexts that connect it with meaning’ (22), with the ‘activities of interpretation, choice, and decision’ (118) key. A cognitive assemblage is Hayles’ way of explaining how these activities are connected, and how information is fed through such a system in order to aid these cognitive activities of interpretation, choice, and decision.

As Hayles continues, she casts her attention towards infrastructures and technical cognition, specifically focusing on LA’s ATSAC, designed to ‘control … traffic on 7,000 miles of surface streets’ (Hayles 2017, 121). As she explains:

> The computer system at ATSAC’s heart, fed by information flowing from sensors and actuators throughout the city, is flexible, adaptive, and evolutionary, capable of modifying its own operations. Combined with operators who work with it, ATSAC illustrates the ways in which technical nonconscious cognition works with human capabilities to affect the lives of millions of urban inhabitants. (121)

Thus, for Hayles, this computer system ordinarily involved in regulating traffic flow in LA is an example of a cognitive assemblage, ‘flexible, adaptive, and evolutionary’ like other (more human) cognizers. In plainer terms, ATSAC is a traffic management system that not only offers a ‘synoptic’ oversight of LA’s road network but does so with an arguably high-degree of cognitive independence.

However, as Hayles asks: ‘how do the technical cognitions instantiated in ATSAC interact with human cognitions?’ (Hayles 2017, 122). In principle, the system finds patterns in traffic information to optimize traffic flow. But in addition, *drivers* ‘also detect patterns’ (122) – when ‘anomalies occur, they are quick to notice and often call the center to alert operators to problems at particular intersections’ (122). In turn, operators too are required to ‘internalize the patterns’ (122) to make decisions themselves. Thus, there is a certain interdependency at work between ATSAC (the technical system), drivers, and operators – each feeding their own situated information and pattern-recognition skills into the functioning of the other; significantly affecting the activities Hayles mentions of interpretation, choice, and decision.

What ATSAC operators do cannot be considered as a form of microwork. They do not work remotely, on ‘single short tasks’ (Tubaro, Casilli, and Coville 2020, 3), outsourced to them in a piecemeal fashion. However, the work performed is in combination with a pattern-detecting system, in which algorithms are used to optimize traffic flow. One of Tubaro, Casilli, and Coville (2020) categories of AI microwork – AI preparation – is not especially relevant. From Hayles’ account ATSAC operators are not tasked with training the system to recognize traffic patterns, nor contribute to the generation of training data used to refine such recognition processes. However, two further categories outlined by Tubaro, Casilli, and Coville (2020) – AI imitation and AI verification – are.

Official accounts emphasize the automated aspect of the system. LA’s Department of Transport (LADOT) suggest it ‘runs the most advanced signal system’ in the USA (LADOT 2020, n.p.) since their own staff ‘invented technology to automatically adjust signal timing to more dynamically move traffic’ (n.p.) during the 1984 Olympics. ATSAC operators (or ‘engineers’ in LADOT parlance), ‘see graphical representations of traffic conditions’ and ‘are automatically notified when traffic conditions are abnormal’ (n.p.). As they explain elsewhere:

> The most advanced parts of the system are adaptive, meaning that the system monitors traffic volumes in real time by direction using detector loops between and at intersections, and changes the signal timing as traffic conditions change. (LADOT 2016, 2)

Here, the automatic notification of abnormal traffic conditions feed into the automatic adjustment of signal timings, in an ‘adaptive’ process, where the system evidently receives, and acts on, critical traffic information to ensure ‘flow maintenance’ (Luque-Ayala and Marvin 2016, 196). Other accounts further emphasize the technological aspects of the system, highlighting the '25,000 embedded sensors' across LA, the operation of 'approximately 450 closed-circuit video cameras', and 4,400 'signalized intersections' (Bliss 2014, n.p.).

Two details in this latter account crystallize the relevance of AI imitation and AI verification to ATSAC. Firstly, it contends that '[m]uch of its infrastructure isn't visible to drivers' (Bliss 2014, n.p.), with only the 'slightly raised areas on top of the pavement hint[ing] at the sensors below the surface' (n.p.). On the road network itself the automated work is hidden, with barely a glimpse of the infrastructure that manages traffic flow in LA. But it is in these various accounts the 'automated' system is (almost literally) surfaced (raised areas, detector loops), centered (25,000 sensors, 450 cameras, 4,400 signalized intersections) and proudly celebrated (the most advanced signal system in the USA).

Secondly, it does hint that '[e]ngineers can manually override the main ATSAC computer, but they rarely need to' with the system 'programmed to adjust instantly and keep lanes flowing' (Bliss 2014, n.p.). ATSAC operators (engineers) are cast as mere supervisors, only intervening on occasion to 'correct' the system itself. In this, there may be no imitation in the same sense as Tubaro, Casilli, and Coville (2020) detail, but the human work – such as the pattern-recognition described by Hayles – is certainly elided; reduced in these latter accounts to system correction, less still verification. The system, in such accounts, needs no such verification: it works just fine, most of the time.

Vehicular intervention as normal operation

I use Hayles (2017) to make two distinctions. Firstly, to expand the conceptual understanding of distribution beyond cognition itself, incorporating situated decision-making, more broadly. In this, I want to account for the 'corrective' procedures hinted at above which, I argue, constitute substantial interventions without which a so-called 'automated' or 'autonomous' system could not operate at all. Accounts of distributed cognition do not effectively capture the significance of such interventions, rendered mute by reference to 'pattern internalization' or similar cognitive tasks. Whilst ATSAC demonstrates the distributed monitoring of, adjustment to, and intervention into traffic, only the automated monitoring and adjustment of traffic flow is considered normal. Any such intervention made by ATSAC operators is rare and, as such, external to the (perceived) ordinary conditions under which the system operates. Thus, to summarize: both Hayles (conceptually) and LADOT (operationally) downplay the significance of interventions, although for Hayles this is to elevate cognition, whilst for LADOT this is to centre the automated system itself.

However, in this comparison between LA's ATSAC and Nissan's SAM project there are notable differences. Firstly, that ATSAC monitors and adjusts the *aggregate* movement and flow of individual vehicles as they move along city streets and highways. Whilst ATSAC can 'control' traffic by adjusting signal lights, for example, this power obviously does not extend to the vehicles themselves – although the effect, of course, is felt at the level of individual vehicles. By comparison, as I detail later, Nissan's SAM envisions the monitoring of, and intervention into, *individual* vehicles, the non-aggregated units that comprise 'traffic'. This results in a scalar distinction (city-wide, manufacturer-wide), but also further analytical (traffic to vehicle), and operational distinctions (signal control, vehicle soft/hardware control). These distinctions only highlight the envisioned normalcy of interventionism offered by SAM.

Secondly, that when ATSAC engineers intervene in the flow of traffic throughout LA, they do so from a *central control room*. Whilst the room imagined by Nissan might have screens, maps and live video feeds just like in LA, I contend that it would be closer to a call centre in which decision-making tasks (rather than phone calls) would be 'assigned' to workers, depending on their availability, and/or expertise. Whilst the total number of ATSAC engineers needed in the control room appears low (Los Angeles Department of Transport (LADOT) 2020), the volume of mobility managers would likely be higher if Nissan's own goals for the project were reached, with the work itself of a more constant, repetitive nature, as workers view video feeds and draw lines on a screen. In other words, ATSAC is a centralized decision-making system following a 'control room logic' (Luque-Ayala and Marvin 2016, 192) found in various urban settings, whilst SAM is imagined as a decentralized infrastructure, in which decisions are distributed in order to mitigate and reduce the effects of 'events which are disruptive to [automotive] circulation' (O'Grady 2014, 516).

But that thirdly, also distinguishable from ATSAC, interventions in SAM are *integral* to the running of the system – despite the obvious human control in 'abnormal' scenarios that exceed the capacities of an autonomous vehicle – with live AI trainers or interveners not only meant to *rescue* vehicles from tricky situations, but also *improve* their decision-making capacities in future situations. In this, every intervention made by a SAM mobility manager is a new training event designed to teach the vehicle new tricks, 'preparing' (Tubaro, Casilli, and Coville 2020) it to successfully negotiate previously novel obstacles, in a process of 'terrain-optimization' (Hind 2019). The effect of this is that a form of 'repair and maintenance' (Graham and Thrift 2007, 1) is not just 'bolted-on' to the system but integral to the infrastructural operation itself, in which 'breakdown' (5) is considered neither external to the system nor endangers it.

Except, this training is intended to be performed live, in everyday driving situations, rather than as a precursor to, or preparation for, algorithmic operations in the wild. In doing so, waiting for such interventions is *normalized*, if not altogether 'dramatized' (Schindler 2020, 651), as drivers come to experience the delay as desirable, and necessary. In the management of traffic in LA, ATSAC engineers do not (as far as is understood) perform such a role, despite in Hayles' (2017) account being (along with drivers themselves) attuned to detect traffic patterns. Indeed, that whilst waiting in traffic is normalized in LA, the role of ATSAC operators is to minimize it, rather than further normalize it. In other words, that any delay is seen as a failure of the system, rather than its success.

Imagining the avoidance of obstacles

In this penultimate section I will explore how 'normal' interventions are imagined in a video documenting the SAM project.[2] Having been launched at the Consumer Electronics Show (CES) in 2017 by then CEO Carlos Ghosn (Nissan 2017a), Nissan continued to promote the project to a car-specific audience at the 2018 GIMS. It was at this event in March 2018 that I first encountered the project, seeing frames from the video on a section of Nissan's exhibition stand. I had attended the motor show to witness how established vehicle manufacturers were presenting, and marketing, driver-assist and autonomous control systems. Whilst there was a plethora of the former, from Volvo's 'moose vision' (Adams 2017) to Subaru's 'EyeSight' technology (Subaru 2021), there was a paucity of the latter. Nissan's SAM provided some of the 'sublime' elements of this second category, with a degree of 'mundanity' from the first.

The video provides a rich articulation of Nissan's vision for the SAM project in which an ideal situation, ripe for intervention, is presented in detail. In this, it is a demonstration of a kind of 'street trial' or test (Marres 2020) commonly performed by manufacturers of autonomous vehicle technology to evaluate the public perception of, and reaction to, such a project.

As the video boldly suggests:

> Developed from NASA technology, SAM partners in-vehicle artificial intelligence (AI) with human support to help autonomous vehicles make decisions in unpredictable situations and build the knowledge of in-vehicle AI. This technology could potentially enable millions of driverless cars to co-exist with human drivers in an accelerated timeline. It is part of Nissan Intelligent Integration. (Nissan 2017b, n.p.)

The video begins with the iconic words of Neil Armstrong in 1969. The earth as the 'blue marble' (Cosgrove 2003) is glimpsed, with spacewalking NASA astronauts in the foreground. A montage of NASA projects follows, from laboratory tests of bipedal robots to terrestrial demonstrations of 'lunar rovers'. The director of the Nissan Research Center in Silicon Valley, Maarten Sierhuis, then appears to contend that such NASA technologies can also be used to 'solve problems that we face here on earth'.

The NASA lunar rover is meant to embody the new logic of testing (Marres and Stark 2020) as imagined by SAM. Designed for planetary exploration, the lunar rover collects materials and captures images with the assistance of a crew back on Earth. As Janet Vertesi suggests, 'it is only through constant interaction – with image-processing software suites, with teammates, and with their robots – that team members can conduct their science . . . ' (Vertesi 2015, 14). Yet in the same way that Haigh (2019) argues that Google's 'X' division mis-sells itself as a 'moonshot factory' (24), so Nissan's SAM project offers a false equivalence between NASA's efforts to understand planetary life, and their own attempts to understand life on the road. Rather than using probes to bring back materials from environments 'at a distance from the familiar settings of everyday life' (Marres and Stark 2020, 427), to laboratories also distinct from everyday social spaces, SAM envisions a form of (differently distanced) intervention that not only normalizes the ongoing modification of everyday driving environments but driving *practices* too.

This process of understanding is gained through the probing intervention of mobility managers, ready to negotiate obstacles on behalf of autonomous vehicles. At no point is the human element backgrounded. Instead, it is surfaced as a critical dimension of the logic of testing at hand, in which the wait for remote intervention becomes doubly advantageous for the driver: firstly, in enabling the real-time negotiation of the vehicle around an obstacle, and secondly, in ensuring the training of the autonomous vehicle's capacity to make decisions in the future. In both, the experience of riding in the vehicle is enhanced, with the built-in decision-making delay instilling confidence that the system works, even if such a delay is ultimately there to be reduced, or wholly eradicated through the cumulative interventions of mobility managers.

At this point the video switches to 'life on the road' – cars bumper to bumper – as Sierhuis informs us it will be 'impossible to have fully autonomous vehicles driving around without ever needing help'. 'Any autonomous system' he continues, 'is built by humans, for humans'. Nissan's solution, therefore, is a system for 'seamless integration into human society', as a NASA-branded vehicle roams a model lunar landscape, and a Nissan Leaf appears in shot. At this point, Melissa Cefkin, principle scientist at the Nissan Research Center introduces us to SAM for the first time; 'a system of support for autonomous vehicles, and for transportation systems'. In this, the ordinary traffic jam is depicted as an everyday occurrence, a kind of 'dumb' form of waiting that establishes SAM as an intelligent alternative.

To explain, Sierhuis returns to tell us it is not unlike 'air traffic control', that whilst there are 'thousands of airplanes in the air' and 'pilots in the cockpit', 'humans at a distance controlling and observing . . . airspace' are still required. The inference is that SAM does the same job but on the ground, ensuring traffic is running smoothly. Air traffic control is an imperfect comparison as it does not directly enable control of aircraft, is primarily concerned with the management of air *traffic* (that is, aircraft in aggregate) or *space* (Budd 2009), and principally used in just two situations: take-off and landing (rather than the 'control' of aircraft in flight (Hind 2020)). Yet the comparison does establish one critical connection: that remote operators are able to intervene in flow of vehicle movement, introducing necessary, good, 'intelligent' delays that make the automotive experience 'better' and 'smarter' through 'social navigation' (Hind and Gekker 2014).

The video then explains SAM in more detail: firstly by identifying the type of situation it might be used for, and then, by detailing the sensing systems used by the vehicle. Here, a small group of scientists are huddled around the NASA lunar rover, protected by the line of orange traffic cones (Figure 1). The Nissan Leaf's assemblage of cameras, LIDAR unit, 'laser range finder' and 'mili wave' technologies, we are told, will be able to 'assess the situation, and build a picture of the world based on the best parts of each sensor'. What Nissan calls 'sensor fusion', as Sierhuis continues, is a kind of sensing assemblage, in which different sensing technologies are made 'interoperable' (Wilmott 2016, 2020) with each other, constituting a special kind of 'machinic sensibility' (Hong 2016) in which the operative images generated by the vehicle (Wigley 2021) are transmitted, and on which the mobility manager can draw.

Figure 1. A Nissan Leaf encountering an obstacle as part of the SAM project. Source: Nissan.

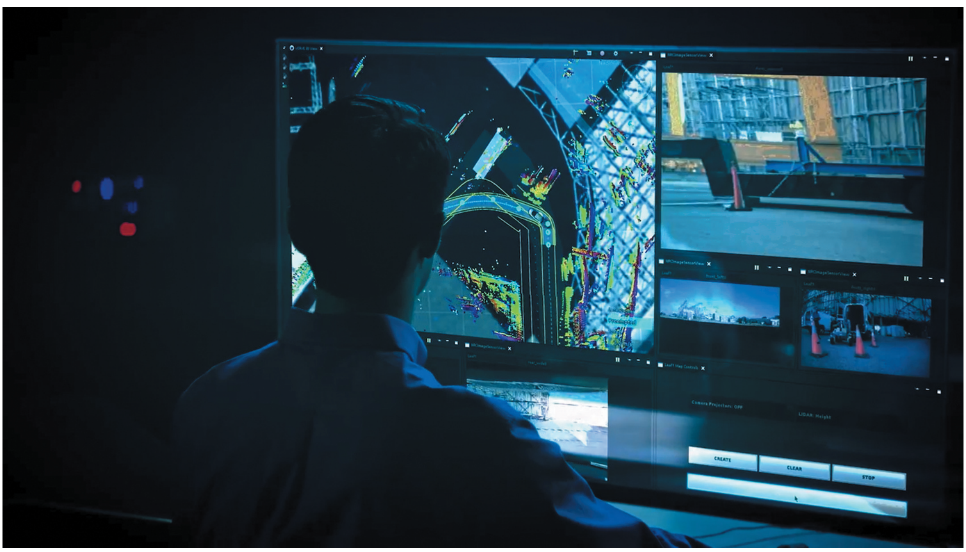

Figure 2. The mobility manager assessing the situation. Source: Nissan.

Next, as in the opening vignette, the video cuts away from the vehicle, to the darkened room with a shirted man behind a widescreen display, who we are informed is the mobility manager (Figure 2). In Sierhuis' words again:

> That picture [of the encountered situation] is transmitted to the mobility manager who then paints a new path around the obstacle. The vehicle can then safely follow that path and continue on. Once this new path is set, artificial intelligence in the cloud will distribute this to all the other vehicles to solve the same problem without the human in the loop. The next autonomous vehicle travelling down the same road will manoeuvre around the obstacle without any assistance from the mobility manager.

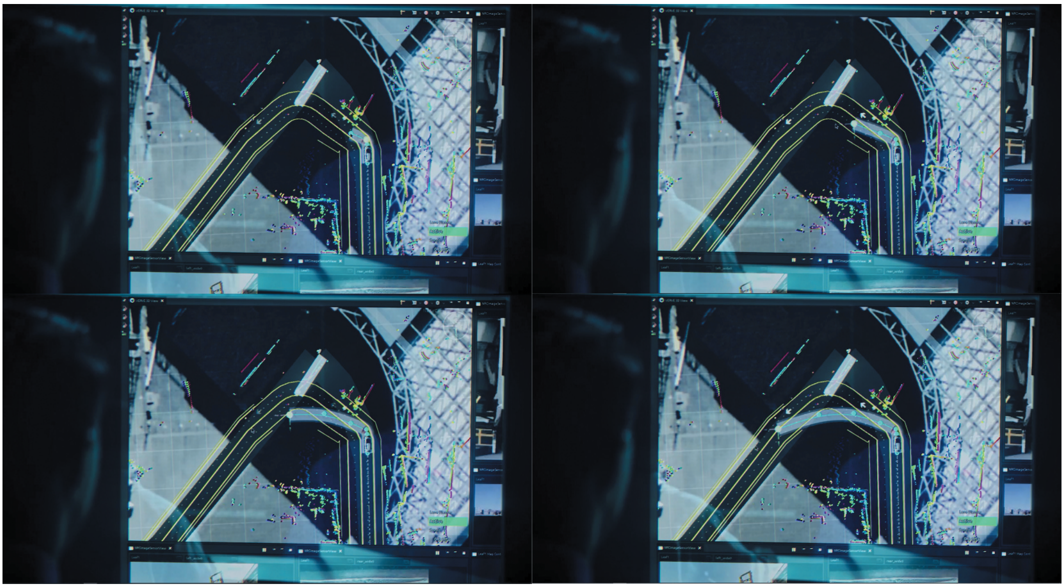

Figure 3. The mobility manager projecting a route. Source: Nissan.

The main window of the mobility manager's display is a birds-eye view of the Nissan Leaf. Satellite imagery of the surroundings act as a basemap, with solid, parallel yellow lines overlaying the road lanes below. At the top left of the same window is a tab description that reads 'VERVE 3D view'. VERVE, it transpires, is a '3D visualization system that provides situational awareness, science analysis tools, and data understanding capabilities for robotics researchers and exploration science operations' designed by NASA (2020, n.p.).

Repurposed for on-the-ground intervention, NASA's 'interactive 3D viewer' enables the mobility manager to utilize the sensor data for the decision-at-hand, incorporating footage into their workflow, to remotely assess the situation. It is here where mobility managers most appear like a fusion of scientists and 'rover planners' (Vertesi 2015, 40) on NASA lunar projects both interpreting and annotating sensor data (like scientists) as well as subsequently planning and executing the movement of the vehicle (like rover planners).

Right on cue, the mobility manager springs into action, clicking several discrete spots in front of the vehicle and, crucially, around the identified obstacle (the van, the scientists, and the lunar rover). As he does so, a cyan-coloured dot in front of the vehicle is connected by a thin, curved, cyan line to another dot that has appeared where the mobility manager has clicked. The mobility manager proceeds to make three more clicks, projecting a route for the vehicle to safely follow (Figure 3). A grey area appears beneath the cyan line, showing the space the Nissan Leaf is expected to occupy.[3] As the video cuts away to the vehicle and then back to the mobility manager, the Nissan Leaf is seen proceeding along the new route (Figure 4).

Intervention as automotive microwork

Nissan's vision as portrayed in the video is different to that posited in another Hildebrand (2019) analyses from 2015. In this, the idea of the 'technological sublime' is embraced, with the autonomous concept vehicle framed as 'exhilarating, empowering, and reliable' (162). In one scene, the concept vehicle drives along a street 'respecting traffic, sensing cyclists, and politely communicating with pedestrians', arguably 'within highly controlled parameters' (164) that nonetheless portray the

Figure 4. The Nissan Leaf avoiding the obstacle. Source: Nissan.

vehicle as both sensible and singularly intelligent. In contrast, the SAM video is happy to show the Nissan Leaf as fallible but Nissan SAM as *socially* intelligent; with the vehicle happily reliant upon human intervention when faced with a new and confusing situation.

The intervention itself is a modest, almost banal one, in which a remotely located individual behind a widescreen display simply, and calmly, projects a path for a vehicle around an easily observable (at least for a human) obstacle. Yet the purpose of the intervention, as briefly mentioned already, is two-fold. Firstly, it is to intervene in the negotiation of an obstacle the vehicle is incapable of doing alone. In such a moment the vehicle suspends its autonomy and calls for help in the form of the mobility manager. From a remote location more akin to a call centre than a control room, the mobility manager is instantly shown an array of live feeds: multiple camera perspectives from the vehicle itself, plus a satellite image with brightly coloured lane markings and relevant objects overlain. The mobility manager assesses the situation, recognizes the obstacle to be negotiated (the scientists unloading a lunar rover), and proceeds to draw a route around the traffic cones. Yet secondly, these on the road, in the wild, interventions are intended to directly affect ordinary (but not so ordinary) driving situations, teaching the vehicle to ultimately perform such actions independently. A vision of a different kind of 'infrastructural ideal' (Manderscheid 2014, 613), offering a decentralized 'mode of regulation' (617).

From the video we know little about how both parts would actually work: the expertise and training of the mobility manager, the assessment criteria, the established route-drawing protocol, the permissions or clearance given to individuals in charge of remotely operating such vehicles. Or, the cumulative effect of such interventions, the vehicle's learning process, the translation of instructions into commands, or the comparison of future situations with past situations, to see if any of the learnt knowledge applies. Yet, 'aspirationally' (Marres and Stark 2020, 436), what seems clear is that a decentralized architecture is envisioned as facilitating the distribution of decision-making, following a model closer to how AI work is performed (Tubaro, Casilli, and Coville 2020), than to how automotive transport networks have typically been managed.

The intervention is not strictly an example of AI preparation as Tubaro, Casilli, and Coville (2020) define it, although it certainly prepares the autonomous vehicle for encountering similar situations, or similar *categories* of situations, in the future. It is also not an example of AI imitation, as the mobility manager – as remote as they are – is not hidden behind the 'magic' of the auto-nomous, auto-mobile. It also is not necessarily an example of AI verification performed after a 'output' produced by the vehicle. Instead, the intervention is arguably a new category of 'automotive microwork' altogether, in which elements of preparation and verification are combined with this direct intervention. Further, that any such preparation or verification is not done prior to (preparation), or after (verification) the autonomous vehicle has acted, but carried out in the midst of it performing actions, movements, or manoeuvres suspended when the mobility manager is called to assist.

The obstacle in the video, a van being unloaded, is unlikely to appear the same each time. The ad-hoc nature of unloading a vehicle (different van, different items, different people) means it cannot be mapped in advance like any permanent feature (tree, traffic light, building etc.). Whilst the aforementioned 'sensor fusion' vaunted by Sierhuis is likely to be able to recognize the amalgam of objects in the picture, from the scientists to the parked van, and even from the lunar rover to the traffic cones, their incursion into the projected path of the vehicle evidently yields some problems. In this, the Nissan Leaf – as far as SAM explains – is unable to generate a new path around the obstacle. Instead, it comes to a halt before it (sensing, quite literally, a problem) and calls the mobility manager for assistance.

Yet once negotiated, the vehicle (in theory) assumes knowledge of how to negotiate such an obstacle, incorporating the expertise of the mobility manager into its own sensing capacity. Here, the category of situation encountered by the vehicle, 'a van being unloaded that requires the moving of lanes' becomes knowable by the vehicle, and other connected vehicles in the network. Although such scenarios are not uncommon, the specific conditions of each may well be. Unlike herculean efforts to build comprehensive databases of both obscure or complex kinds of road types or junctions, to which any autonomous vehicle can directly refer (Madrigal 2017), Nissan's proposal instead contends that the initial encountering of peculiar events can be negotiated, on the fly and in the wild, by its own special 'fusion' of traffic manager-cum-AI worker, NASA scientist and rover planner, the intervener.

Throughout the video the vehicle occupants are mysteriously invisible, reduced to a silhouette as in (Figure 1), or elided by windscreen glare as in (Figure 4). In a scenario in which the agency of a human driver has already diminished, the expectation that this agency would be happily distributed to another human – complete with a delay – is arguably questionable. Yet in envisioning an automotive future, SAM actively envisions new driving *subjects*, crafting new categories of vehicles that produce new kinds of driving *experiences* and *expectations*. The speculative mundanity of this distributed decision-making is merely an infrastructural extension of a kind of microwork already being used in the automotive industry (Tubaro and Casilli 2019), embodied in other projects such as Aurora's 'teleassist' service (Aurora 2019). Indeed, that it presents a vision that is evidently different from 'panoptic' smart city offerings that work to 'integrate and bind data streams together' (Kitchin 2014, 11) as with Rio de Janeiro's (in)famous Centro de Operações Rio (COR). Instead, of offering an 'illusion of total control' (Luque-Ayala and Marvin 2016, 193) as COR does, the 'higher order' dream of distributed decision-making as evidenced with SAM offers a different reality of intermittent, incessant, automotive intervention. As a result, it is not a stretch to consider how the future of automobility might be built on distributed, digital infrastructures: workers making decisions on behalf of, and through, remote technology to solve immediate navigational issues. What appears somewhat unique is that such (micro)work occupies a prominent place in Nissan's vision, remote from, but not hidden behind, the action.

Conclusion

In this article I have suggested that rather than offering a version of a technological sublime, some automotive manufacturers engaged in the design of autonomous vehicles dream instead of distribution. Rather than celebrating the power of algorithmic decision-making, or emphasizing the precision of cartographic data, others envision forms of remote, human control in which workers intervene in the decision-making of vehicles themselves. Embodied in Nissan's SAM project, this vision normalizes a future of driving in which vehicle occupants are expected to wait for decisions to be made, in return for an enhanced driving experience; freeing the driver from not only physically controlling the vehicle, or performing driving-related tasks, but from having to make decisions altogether.

However, SAM 'doesn't just solve problems' as the video I have analyzed in this article suggests, it creates them too, as decisions, risks, and responsibilities are distributed throughout a decentralized infrastructure. This 'speculative mundanity' as I have referred to it showcases, rather than deliberately hides, the human decision-making at play. What is critical to this vision is the desire to normalize interventions that benefit both the immediate driver, and all others connected to the network. These interventions, as I have argued, are a distinct form of AI microwork that elide existing categories such as AI preparation or verification. Instead, mobility managers can be thought of as interveners, assisting the autonomous capacities of a vehicle under their fleeting control. The vision of re-distributing vehicle control away from the driver, not only to the vehicle, but also to remote workers, is thus significant, as each intervention is meant to educate the autonomous vehicle and other connected vehicles, in correctly responding to similar encounters in the future.

Traffic management systems are perhaps the most relevant example of the distribution of automotive decision-making, despite the uniqueness of SAM. Hayles (2017) analysis of LA'S ATSAC introduces one such case, in which such systems are understood as 'cognitive assemblages', with cognitive tasks variously distributed between a computer system reliant on a network of sensors located across LA, and ATSAC operators in a control room. In this article I have preferred to refer to such projects as Nissan's SAM as examples of distributed decision-making to instead foreground the distribution of interpretive acts and interventions required to keep vehicles moving at a distance. In contrast to the operators of ATSAC, interventions by SAM's mobility managers are decentralized, integral to the improvement of the system, and contribute to the normalization of a new, desirable type of driving delay.

Yet, the article has not intended to portray Nissan as a more pragmatic manufacturer, in contrast to big tech companies' glossy, highly improbable visions of a fully autonomous future. Indeed, it is striking that Nissan plays a double-move: at once foregrounding the human labour involved in executing decisions in ordinary driving situations, whilst still maintaining that such a system demonstrates seamless autonomous mobility. Here I have suggested that Nissan's vision of speculative mundanity extends current trends within and beyond the automotive industry, in which AI-based 'automotive microwork' is a critical component.

The video I discuss in the article emphasizes the involvement of NASA, drawing direct links between the space agency's lunar rovers and the Nissan project back on earth. Here, Nissan deploys the language and form of scientific work, to strengthen the intelligence of the project, suggesting that the automotive mobility managers imagined in Nissan's video are not unlike operators in a mission control centre, guiding robotic vehicles from afar. Yet reference to NASA's lunar missions belies the work at hand, itself a fusion of drawing and driving (Vertesi 2015). Indeed, as I have suggested, SAM offers a new logic of testing (Marres and Stark 2020) in which the everyday, social life of driving is itself being intervened *in*, and operated *on*. The desired results have the possibility to radically shape automotive practices in the future.

Notes

1. Acting also as legal buffers, as in the case of Rafael Vasquez, a 'Vehicle Operator' (VO) for Uber ATG who was charged with negligent homicide following a fatal crash, demonstrates (Porter 2020).
2. The full video has since been removed by Nissan, but an identical version can still be found online (Nissan 2017b). B-roll footage of the interviews and mobility manager visuals are also still available, from which some of the figures in the article derive (Nissan 2019).
3. This is often referred to as an 'occupancy set' within robotics research, see Pek et al. (2020).

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