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Scientific research and technological development are heralded by some as the main means for preventing climate change, by devising ways of reducing emissions, improving energy efficiency or even capturing carbon already released into the atmosphere. Research teams throughout the world are working on engineering solutions in a variety of fields: from cars to buildings, from light bulbs to domestic appliances, from new materials to software applications.

However, it is crucial to examine whether R&D endeavours are taking into consideration social needs and concerns, local knowledge and lay expertise; that is to say, if citizens are being involved in the definition of research questions, in the process of data collection or in the design and implementation of technical solutions.

This paper is based on a case study of a R&D project developed by a Portuguese team: CleanDrive, an educational simulator for safe and environmental driving. But how have human and social characteristics been factored in the project? Which conception of user is explicitly or implicitly assumed by the research team? How was the device tested in real human subjects? What reactions has it been eliciting from users?

Technology and climate change

The core role science plays in environmental issues has been often stated and analysed (Irwin 2001; Bocking 2004). Much like other environmental risks and problems, climate change is a privileged field for studying the interplay between science and society.

Extensive scientific research and technological development are being carried out to assess, mitigate and adapt to climate change: "it makes sense to invest in new knowledge. (…)

Mitigation may require developing new technologies that will allow economic development while reducing the anthropogenic contributions to climate change. (…) Anticipatory adaptation will require foresight about impacts and new technological and social developments to respond to them" (Rayner and Malone 1998: 4).

Policy decisions on mitigation and adaptation measures cannot be but based on scientific evidence and advice, in a dynamics in which "natural knowledge and political order are co-produced through a common social project that shores up the legitimacy of each" (Jasanoff and Wynne 1998, 16; see also Miller 2001), but also on citizen participation, through networks that involve governmental actors, NGOs, business companies and communities (O'Riordan et al 1998).

Mitigation and adaptation to climate change requires not just changes in the practices of governments and business companies but also in individual behaviour and consumption (see Tompkins and Adger 2005). Technology plays a role in promoting those changes: "the focus on dynamics of technical change and how to manage it has important implications about the role of technology in climate change and the expectation (…) that sociotechnical change will be important to resolving the issues of climate change" (Rip and Kemp 1998: 387).

However, so far, according to Shove et al, technological development aimed at preventing, reducing or adjusting to climate change has often failed to take into account social conditions:

> those who develop and design policy measures and technologies incorporate a range of beliefs and hypothesis about the future behaviour of those they seek to influence. As well as making implicit assumptions about future social practice, policymakers, engineers and technologists have tended to adopt an overtly economic paradigm and a formal language that brings with it a somewhat restricted vision of the relationship between change, technology and people (1998: 298)

For many social scientists, changes in consumer behaviour that can only be brought about by "creating shared frames of reference and opportunities for shared action" (Rayner and Malone 1998: 13) and not just by providing scientific information (see Kellstedt et al 2008) and advertising new eco-friendly technologies.

Methodology

The case study presented in this paper is part of an ongoing research project on the science of climate change in Portugal.

The first stage of this project comprised a census of R&D projects in the area of climate change in Portugal in the past decade. Starting with the list of projects supported by competitive funding from the Portuguese government (FCT - Foundation for Science and Technology) between 1999 and 2008, 109 projects were identified in which climate change figured as a main scientific area, secondary scientific area, keyword or word in abstract. A sample of these projects, stratified by scientific area and subject, has been selected for an in-depth analysis, among which "Cleandrive".

This case study was analysed through a combination of methodologies and techniques[1]. Firstly, a set of documents was compiled and analysed: the project file, newspaper articles, tv programmes, powerpoint presentations by research team members, leaflets and websites. Secondly, interviews were carried out to research team members (interviews 1 and 2 in this paper) and to representatives of organisations that use the resulting technological device (interview 3[2]). Lastly, ethnographic observation was carried out at two public events in which the technological device was used.

This paper will present only a very preliminary analysis of the data collected, being solely of an exploratory nature.

The R&D project

"Cleandrive" is a research project submitted for funding in the 2004 FCT competition by two teams belonging to different research centres of the same prestigious engineering school in Lisbon, one in mechanical engineering, the other in computer engineering. The project was assessed by a panel of experts in the scientific area of Environmental Sciences and Engineering, although Transports was indicated as its secondary scientific area. The project was awarded 53,000 Euros and started in 2005, lasting for two years.

The main aim of the project was to design a driving simulator that would accurately reproduce the performance of a vehicle in terms fuel consumption and greenhouse gas emissions, in response to road conditions and to the driver's behaviour. The purpose was to create a game in which safe and good ecological driving, instead of speed or skill, would be rewarded. This project would draw on the expertise of two teams:

- a group of software developers, who had never worked in environmental subjects but were experienced in designing visually attractive virtual scenarios
- a team of environmental and mechanical engineers, who in previous projects had devised mathematical models to calculate fuel consumption and greenhouse gas emissions according to a wide range of parameters. For this team, this project was a "natural" evolution within their work:

> We are a team that work in four areas, always in the area of transport sustainability; the first area is fuels of the future, we have a lab for monitoring vehicles, with different combustion types; the second is new vehicles; so we have the fuel and the vehicle, and if we think this through, the fuel and the vehicle offer mobility, [the third area] has to do with research in the area of mobility, to estimate accessibility, to estimate impacts, estimate advantages (...); and there's the fourth fundamental area, an area that no one gives any value, which is the behaviour area, all of this is used by an human being. (...) all the tools I invent to change behaviour, to measure behaviour e to optimise what people are doing in their day to day lives have become missions of our team (interview 2)

[1] I am grateful for the collaboration of Joana Borges Coutinho in some of the stages of this case study.
[2] A fourth interview has been requested, the said organisation declined, although they showed willingness to issue a written statement (which has not yet been received).

Besides the research team, which was made up of university professors and grant holders (postgraduates), undergraduate students have also been participating in the project and developing specific features of the software, as part of their degree training.

The decision to include both safety and environmental issues in the simulator was considered as "inevitable", since the initial target audience for the simulator were future drivers, that needed to learn not only good environmental practices (in terms of economy and emissions) but also safety rules: "we think the three aspects are not dissociable, that one doesn't prevail over the other, that is good to practice economical and environmentally friendly driving but at the same time it has to be safe, that you have to follow the basic rules of driving and any driving simulator had to include the respect of these rules, for sure" (interview 1).

According to the research team, alongside scientific publication, a wide dissemination of the prototype had always been one of the core objectives of the research project, something that was highly commended by the funding agency. In Portugal, the dissemination of research results and contribution to the public understanding of science is a criterion increasingly considered in R&D assessments and many research centres, like those involved in this project, have press offices that send out information about their most "attractive" innovations.

The prototype

The resulting software recreates a detailed rural or urban environment (with roads, sidewalks, buildings, other vehicles, traffic signs and lights), in which the user has to drive around for a set amount of time (which can be adjusted beforehand). The user can choose between different vehicles (cars, jeeps, lorries, buses), using different kinds of fuel (gasoline, diesel, biodiesel) and with different types of transmission (manual, automatic, semi-automatic). The screen shows not only the road ahead, but also three rear-view mirrors, approaching traffic signs, the speedometer and the tachometer and indicators of fuel consumption and four kinds of emissions, as well as the time elapsed and score obtained. The simulator responds to commands from a driving wheel, pedals and gears, as well as to elements within the simulation (climbing sidewalks, collisions with other vehicles and stationary objects). The simulation also has sound, reproducing motor hum and rev noise.

At the end of the simulation, a table is shown containing the number of traffic infractions that were committed and the safety score obtained, the amount of fuel spent, the chemical symbols of the greenhouse gas emitted (CO2, CO, HC, NOX and PM) and the distance travelled. However, there is no indication whether these results are below or above average or comparable to any standard and the researchers acknowledge that that is a major flaw of the simulator, but one that would require extensive testing in "real life motors" to achieve. The researchers take a lot of pride in the scientific accuracy of the models and seemed unwilling to compromise on precision in order to make the simulator more informative. As it is now "only an expert will look at the gasses emissions and say 'I did really badly in terms of eco-driving', because he would look at the figures and say 'I emitted whatever much grams of greenhouse gas', only an expert will know" (interview 1). However, the researchers did come up with what they call a "metaphor" to signify that the user surpassed a certain threshold that is

environmentally dangerous: if the driver oversteps on the accelerator, the screen is filled with puffs of black smoke.

Besides designing the software, the team also produced a physical interface in which the simulator could be shown: a bright orange car-shaped contraption, with a driving seat, a steering wheel, pedals and a computer screen (as well as a hidden computer in which the software is run). With the exception of the outward shell, all this equipment was acquired from a commercial brand that is used for all kinds of driving simulators. The researchers are not fully satisfied with this prototype, but financial limitations have prevented them to improve it:

> We would like it to be much more realistic but that would involve a pneumatic structure, in which the player would have the feedback whenever he braked or climbed a sidewalk, he would feel that he is performing a series of physical manoeuvres. That physical support doesn't exist, what we have now is a cheap steering wheel, around 250€, that vibrates when he climbs the kerb. (...) we would like to include peripheral vision (..) peripheral vision is very important (...) we would like to generate a set of random events that would force the driver to react to what he sees in the rear mirrors. (interview 1)

The researchers also would like to include a printing option, in order for the users to have access to a report on their driving, as well as a way of compiling results in a database to make before/after comparisons. The possibility of including pedestrians and other realistic elements (such as potholes) in the simulation is also being considered.

This prototype has since been shown in a wide variety of events, throughout the country, to which the team was invited: environmental-themed seminars and events, innovation fairs and exhibitions, youth festivals, activities to promote the host R&D centre or the engineering school, etc. The programme of these events often includes a lecture or presentation, but the highlight is usually the opportunity given to the audience to try the simulator. In some cases, members of the research team are present, in others the prototype is sent "on its own", although it always requires a person to activate it and to provide some explanations. The researchers stated that in these events the simulator always attracts a lot of attention, especially from young people and some parts had already to be replaced due to damaged inflicted by intensive use. The simulator also attracted considerable media attention: it was featured in newspaper articles, radio and tv programmes.

The mediators

Unlike many RTD projects which never make the transition from the laboratory to the "real world", the simulator has attracted the attention of several public and private entities, which have shown an interest in acquiring it. They are here labelled as "mediators", since they intermediate between the researchers that created the technological device and final consumers that actually use it.

A local authority in the vicinity of Lisbon, which had had come into contact with the prototype at an event, commissioned the research team to make some changes in the programme, namely by including in it the roadmap and landmarks and of its city. The funding provided was spent mainly on manpower (grant holders) to make these alterations. The simulator is being used in both a programme for promoting ecological driving among secondary school students and in occasional environmental or youth events. For the first purpose, the equipment (a laptop computer, a portable extendable screen and projector, steering-wheel and pedals) is brought into a school and set in a classroom, using the available furniture (a desk and a chair). After a 10 minute presentation on the role of the transport sector in climate change and some data on road accidents, the students take turns in using the simulator and the points they obtain are registered. The instructor explains the purpose of the game and the rules for driving in a more ecological way, saving fuel and reducing emissions. Although the software provides more information, an emphasis is placed on CO2, because is the greenhouse gas with which the students are more familiar with. Leaflets are distributed, listing tips on how to drive ecologically. In 2010, this programme was meant to be applied in 10 classes, at 5 different schools. Secondary school students were chosen as target population because most of them are close to obtaining a driver's license and are supposedly more familiar with the procedures for driving. The main objective of the programme is described as "to raise awareness among young people on the impacts of the transport sector in climate change" and the secondary objectives as "to promote ecological driving, with fewer emissions and less wear and tear of vehicle components; to promote safe driving"[3].

A governmental office, in charge of mobility, transports and road safety, also opened negotiations to buy a version of the simulator, but in this case no actual agreement has yet been made. Their intention was to obtain a software programme that could be widely distributed to promote eco-driving. Their requirements would be to have a more accurate depiction of scenarios, following the standards for road width, kerb height, road markings, etc.

Currently, the most regular use of the simulator is being made by a small company, a spin-off of the mechanical engineering research team. This company provides training and consulting on transports, energy and environment for other private companies and public organisations. The simulator is used mainly on awareness raising events

> in awareness sessions the simulator has a much more important role because there is not such a strong component in terms of themes and contents and so the simulator is more fun, it attracts people if it's in a fair or exhibition, it draws more participants (interview 3)

and in training sessions, as a complement to theoretical presentations and real driving monitoring, in which a device is installed in vehicles and registers data (speed, braking and accelerating, rpm management, running at idle), in order to build a driver's profile, which is then analysed and suggestions are made to reduce fuel consumption and improve environmental performance: "sometimes a practical session has waiting periods, so we use the simulator to raise awareness, to occupy waiting time, it's not an essential tool but it's attractive, it helps us manage time." (interview 3). The secondary role of the simulator as a

[3] Activity Plan of the Environmental Department of the local authority.

training tool is explained by “its level of development, we don’t think it’s mature enough to be an autonomous product for training (...) it lacks investment, it’s more an issue of detail, essentially graphic issues and virtual reality, to try to make the simulator more realistic” (interview 3).

To some extent, each new client of the simulator brings its own requirements, which the spin-off company, with the help of the research team, tries to oblige, for instance by adjusting the parameters of the simulation to the type of vehicle their clients already use or by changing the circuit to make it more diverse and fully coverable within the time limit.

The researchers believe that the full potential of the simulator is yet to be fulfilled. For that, it ought to be bought by a company that would turn it into a commercial product, but they feel that is not the University’s mission: “in this area of climate change, we need someone that takes the solutions [developed in the Universities] and makes them work, otherwise it’s worthless” (interview 2)

The role of humans: testing and using the device

The simulator is considered by its inventors as a “work in progress” that is continuously improved as a result of the feedback given by users.

The first testers of the software were the members of the team themselves: “they are tested initially by the researchers themselves, there are fifteen of us and we all test these technologies, they all experiment their view of how they work and then we try it out in the market” (interview 2).

An early version of the simulator was aimed at younger children and placed more emphasis on safety and traffic rules, including a quiz that would pop up in the middle of the simulation with multiple choice questions (the questions could also be modified in order for the simulator to be used in driving schools). This was removed after testing the simulator in some schools and registering the negative response of children to being interrupted in the middle of the game.

A demonstration done to bus drivers also provided relevant information for improving the simulator: “they gave us a lot of feedback, because that was just the demonstration prototype, and they said: ‘it’s not really like this, I would expect the bus to react like that...’ (...) they kept questioning us, ‘this shouldn’t be like this, you should have done differently, if I step on the accelerator when leaving a bus stop I was expecting it to behave in a certain way” (interview 1).

Training sessions ministered to professional drivers, within the activities of the spin-off company, yielded more detailed advice, which was afterwards incorporated in the software: “we end up being testers of the product, in training sessions we see what’s not working well, sometimes the participants don’t even notice, but we notice that it shouldn’t work like that, we take notes” (interview 3).

The researchers acknowledge that the simulator is counter-intuitive, that it goes against the rules of other driving simulators and that it requires an pedagogical effort to be used in the "correct" way:

> We say: "you don't need to try to make the circuit in one minute, that's not the point, I want you to reach the end of the time limit without running over someone, without sending a lot of gases into the atmosphere, see if you can do it". Because it's complicated, in some situations the drivers feel tempted to step on the accelerator, because they see a straight road, but accelerating has its secrets, the emission of gases and the model that depends on the acceleration, that depends on the gear, the numerical model takes into consideration all these variables, it can estimate the greenhouse gases emission, and the kids react pleasantly to that situation. When they see the black smoke on the windscreen they react immediately, they slow down, they shift into another gear (interview 1)

Nevertheless, in practice things seldom work as foreseen with the laboratory walls. Material constraints and the contingency of users lead to unintended effects.

The two occasions in which it was possible to do ethnographic observation of the simulator being used seem to point in that direction. The first was a technological exhibition of a handful of innovations created at the engineering school that was held in a shopping centre. The main purpose of this event was not to promote environmentally-friendly behaviour but rather to attract students to the school. The exhibition was held in the central aisle of a shopping centre and showed, alongside the simulator, other innovative technological devices, such as an artificial visual prosthesis, portable labs for clinical and DNA testing, a mobile social network, a software aimed at preventing bullying, a webcasting product. The exhibition lasted a week and opened only after working hours and at the weekend. A dozen students from the engineering school acted as instructors, demonstrating the devices and providing information.

Observing the use of (and using) the simulator in this event allowed two main conclusions. Firstly, despite the best intentions of its creators, the simulation is very far from realistic. A small, overcrowded with information, screen, partially obscured by the driving wheel, combined with peripheral equipment that responds unexpectedly and a tiny uncomfortable driver's compartment, all interfere in the use of the simulator, distancing it from the real experience of driving a car. The damage done by hundreds of users to the equipment is starting to show: it is no longer possible to drive manually, so the selection of vehicles is limited, the driving wheel and the pedals have come loose from the structure and are clearly difficult to handle. The usual time limit set is short (2 minutes) and gives little opportunity to get used to the simulator.

Secondly, and what is more determinant for achieving the purposes with which the researchers set out to develop this technology, the simulator is highly dependent on the information provided by the instructor, since it has no written instructions before the beginning of the simulation or explanations of the results after the simulation. In this case, the instructors were clearly unacquainted and unmotivated to provide such information. Besides the briefest characterization of the device as an eco-driving simulator, they were not familiar with the research project, they provided no information beforehand on how to drive in order

to achieve the best results, they were unable to explain the meaning of the chemical symbols in the final screenshot and to assess whether the figures were high or low. One of the instructors clearly conferred more attention to the safety issues (which are more common in driving simulators) and compared her own scores with one of the users.

Nevertheless, it must be conceded that this event had very specific features, its purpose was not to raise environmental awareness but rather to publicise an institution. It is to be expected that in other situations the instructors would be more thoroughly trained.

The second observation took place in the city in the vicinity of Lisbon and was at an event organised by the local authority to celebrate the World Environment Day. Alongside a series of activities aimed at children, the simulator was placed outdoors, in a local park, close to the site where a biker gathering was taking place. The simulator was meant to be used by the bikers and by the parents of the children that were attending the environmental awareness event. Underneath a yellow canopy, a portable screen, a desk and a chair were set up. On top of the table, a laptop computer, a projector, and the driving wheel were placed, beneath were the pedals.

Again, the conditions were far from favourable for operating the simulator. The wind and the sunshine made almost impossible to see anything on the screen, the pedals kept sliding over the pavement, and the desk and chair had very little resemblance with a car. This time, the instructor, who also took part in the sessions at schools, gave more information, both before and after the simulation. She explained the purpose of the simulator, gave a few tips on how to drive more economically and ecologically and commented briefly on the results.

The reactions from the users were diverse. The bikers made little effort to follow the instructions, used the simulator much like any other game (trying to drive fast and skilfully) and showed little interest on the results. What drew their attention more was the possibility of choosing between different vehicles in the beginning, although there were no motorbikes among the options. Conversely, one of the parents that used the simulator tried hard to optimise his driving, showed an interest in his scores and asked to repeat the simulation in order to better his performance.

Although this observation is far from representative and seems to follow too closely social stereotypes, it does highlight one of the dimensions that the researchers that designed this simulator seem to have neglected. The researchers have worked upon an idealised and uniform conception of the user, which leaves out all kinds of social variables, like gender, age, social background.

Information gathered through interviews with representatives of the spin-off company also yielded some information on user behaviour:

> At first sight they think it’s a game. They look at the gear stick and the steering wheel and they think it’s a game. In general terms they think it’s complicated, the first time they try it, because they’re not used to it and there’s these sensitivity issues (that’s why we think it’s important to make it more close to reality), so the feel some difficulties. But they like it, because in the end it shows the results in terms of consumption, they can

> actually see what happens in result of their driving. And there's a lot of competition. And competition among participants helps team-building (interview 3)

However, not all reactions are positive

> it's threatening during a training action to volunteer to use the simulator, it's more comfortable to stand aside and watch, so we try to make it a more relaxed activity (...) beginning is more difficult, after they begin they come back several times and repeat, but people are not used to, people can't handle the steering wheel, it's not the same as driving a car, people perform much worse than in a car, usually the first is laughed at by the others and then nobody wants to go, it doesn't go that well, we try to break the ice... when it's at the end of the sessions we say 'those who don't want to take part can leave the room', to avoid this sort of things (interview 3)

and the interviewees seem to be more aware of social differences between users and the limitations of the simulator:

> People pay more attention to consumption and sometimes to CO2, because now many cars are sold with information on average emissions, but people don't have a lot of awareness, the simulator shows the emissions of other gases and it's very difficult to get that message across because the target audience of our training actions is often made up of people with little formal education, so they have less awareness to these issues and they don't care about these things, they want to know how much they spend, how much they use, because that's what matters at the end of the month (interview 3).

Inducing change: technology disciplining humans

According to Latour (1992), technology often has a dimension of disciplining humans, imposing behaviour by prescriptions encoded in the mechanisms and forcing them to act morally.

A project such as "Cleandrive" is based on a fundamental assumption that human behaviour follows a linear path between information and transformation: if you provide people with information on how their actions impact on nature they will subsequently alter their conduct. That much has been stated by one of the interviewees:

> this human being has to make decisions, whether he drives a car, whether he takes the train, whether he walks on foot, he needs to be re-educated, he needs to be trained to have a new attitude towards the modern world, towards energy. (...) technology is important but it's not crucial, it's more crucial the decision of those who use it, we have to develop technologies that help improve the decision maker (...) we think that the missing piece in the puzzle was the human being, it can't be left out, the human being is fundamental and we believe that new technologies, new vehicles, such as electrical, plug-in, will induce a behaviour change in the driver, once inside such a car people will change the way they look at things (interview 2)

However, these assumptions are based on a deficit model that presupposes lay people are ignorant and that once they are given information they will change their behaviour. This has been disproved by several sociological studies. For instance, Kellstedt et al, by analysing large scale attitudinal surveys, came to the conclusion: "the more information a person has about global warming, the less responsible he or she feel for it; and indirectly, the more information a person has about global warming, the less concerned he or she is for it." (2008: 122).

Bartiaux (2008), challenges the paradigm of consumer's rationality that postulates that people, when provided with information, will react accordingly, by changing their behaviour. She ascertains that "households that are better informed on climate change issue and factors are not acting in an environmental friendlier way. Another important result is that interested householders who receive customised and expert advice to save energy rarely follow this advice" (Bartiaux 2008: 1178). Conversely, is by taking into account the embeddedness of practices in social life and the frames of reference of social networks that changes can be made: "environmentally friendlier practices raise the probability of other such practices and the openness to environmental information" (2008: 1179).

Flynn et al (2010) analysed the value-action gap between environmental beliefs and behaviours, which they conceptualise as thus:

> while expressing strong beliefs about the negative consequences of global warming, or dependence on fossil fuels, or more positive approval of alternative and renewable energy sources, people do not seem to have translated those opinions into practical actions to limit their energy use in their domestic consumption, lifestyles, or travel patterns, for example. It is this apparent 'discrepancy' between stated beliefs (and values) and behaviour, which comprises the so-called 'value-action gap'. (Flynn et al 2010: 159)

They go on to show that several studies demonstrate that pro-environmental behaviour is closely related to socio-demographic variables (for instance, age, income, household size), personal moral norms, personal habits, household routines, infra-structural limitations (technological options, design, etc), economic constraints, inequalities, institutional barriers to change (regulations, standards, laws, etc). Their own research on hydrogen as a source of energy shows that there is a "difficulty of, and their aversion to, changing certain behaviours (chiefly the use of private transport) because it would diminish the levels of comfort and convenience people are used to. Such behaviours are deeply ingrained in the lifestyles through which citizens construct their identities, status, and social affiliations", and that "financial incentives or cutting down bills can be stronger drivers of reducing energy consumption" (2010: 168). However, economic disincentives would bear down on the less affluent and that is perceived as unfair. Tensions between individual and collective impact are also at play:

> Many people were reluctant to commit to changing their behaviour in relation to energy use or transport because they believed that their personal lifestyles were of marginal importance compared with industry's impact on the environment. (...) Individuals felt that their own actions were insignificant unless there was a wider set of transformations in energy use. (Flynn et al 2010: 176).

Again, these authors refute the deficit model: "Public engagement initiatives which simply rely on providing more or better information – and generalized exhortations to adopt 'greener' low carbon lifestyles – are unlikely to resonate with many citizens or consumers." (Flynn et al 2010: 177).

Slob and Verbeek, on the introduction to a volume solely devoted to technology and user behaviour, state that "if arrangements to stimulate the development of new technologies fail to take the behaviour of users into account, unexpected and unintended side effects can occur" (2006: 5). They go on to criticise the "communication and information approach", since "Changing people's attitudes without taking the behaviour-steering aspects of technology into account does not automatically lead to behaviour change".

On this particular issue of transport, Hendrickx and Uiterkamp (2006) looked at how technology and behaviour interact, with a model in which technical innovation and system efficiency interplay with car characteristics, behaviour determinants and actual behaviour, producing environmental effects. Among the factors that influence driving style, they identified individual characteristics (age and gender), infrastructural characteristics (lane width, road surface roughness), and car characteristics (top speed, motor power, car age and size, band, comfort, fuel type, fuel cost). Thus, technological innovations that make cars more fuel efficient or more comfortable may have the negative side effect of increasing driving speed. According to the authors, though it has not been studied yet, "if environmental concerns affect the way people drive (...) then innovations that make cars (appear) more environmentally friendly may tempt people to alleviate self-imposed restrictions regarding, e.g., speed choice" (Hendrickx and Uiterkamp 2006: 102).

Therefore, we may conclude that this particular technological innovation is clearly at odds with the evidence that social sciences have been collecting about the relationship between users, technology and behaviour change. Clearly more interdisciplinary work is needed to improve the social grounding of technological solutions for climate change.

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