Persuasive technology for a sustainable society

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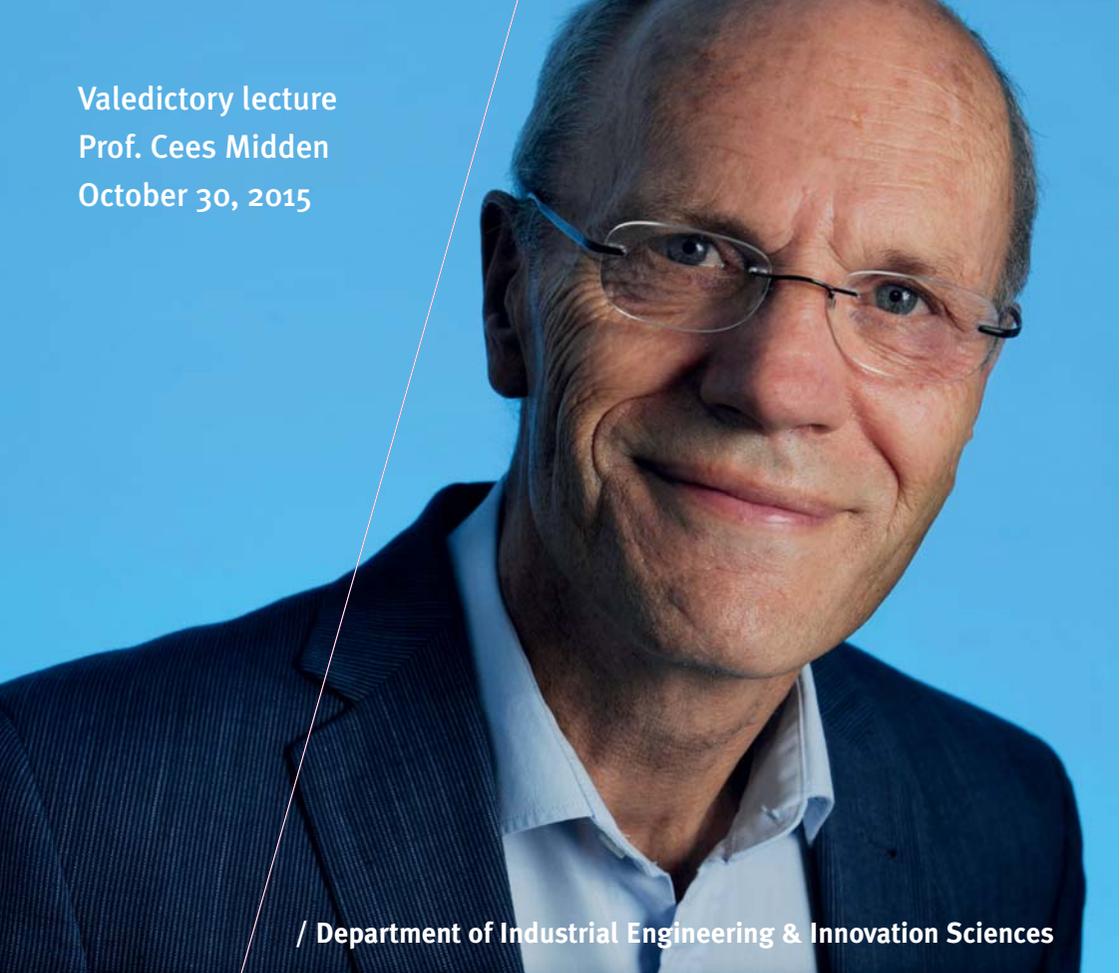
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Persuasive technology for a sustainable society

Where innovation starts

Valedictory lecture prof. Cees Midden

Persuasive technology for a sustainable society

**Presented on October 30, 2015
at Eindhoven University of Technology**

Introduction

The emergence of climate risks is arguably one of the most pressing issues facing our planet and its inhabitants (IPCC, 2014). Since the industrial revolution the stamp of human activity on our ecosystems could not be ignored. The impact of human behavior on the natural environment has now led to transformations that have the power to amplify ordinary weather phenomena into increasingly more devastating disasters. Heat, extreme weather events, and increased competition for scarce environmental resources will affect life on Earth and may foster international conflict and nurture stress and anxiety.

Long-term climate change is a phenomenon not easily detected by personal experience, yet it is one that invites personal observation and evaluation. On average, people seem only modestly concerned about the adverse consequences of climate change, in part because small probability events tend to be underestimated in decisions based on personal experience, unless they have recently occurred, in which case they are vastly overestimated. Many think of climate change risks (and thus of the benefits of mitigating them) as both considerably uncertain and also as being mostly in the future and geographically distant, all factors that lead people to discount them. The costs of mitigation, however, will be incurred with certainty in the near future. Emotional reactions to climate change are likely to influence perceptions of risk. Yet, emotional reactions to climate change risks are likely to be muted because climate change can be seen as a natural process and global environmental systems perceived as beyond the control of individuals, communities and, quite possibly, science and technology. There is, however, significant variability in people's reactions to climate risks, much of which is mediated by cultural values and beliefs.

Obviously, mitigating climate change is a multi-factor issue involving many disciplines. Today, I take the perspective of the behavioral scientist. One reason may be that this is what I can do. However, a career of research on the topic has convinced me that ultimately a sustainable society will be a result of all those decisions and behaviors made by people. Notably, technological innovations are also dependent on these processes. More recently, this awareness has also

reached the agendas of policy makers and several recommendations have been formulated to work on these behaviors.

Sustainable living requires a shift in our lifestyles, familiar routines and rituals, and a redesigning our living environments; regulating needs to explore. It requires designing and adopting novel technological systems and environments: mobility will undergo major changes. It requires a new perspective on working tasks and working environments. This set of necessary changes is indeed really impressive! Can we do it? Will humanity be able to deal with these huge threats to its existence? I consider human responses to climate change as a case of risk management. Firstly, I will argue that the greatest risk is that it does not feel like a risk. It is a devil in disguise. Secondly, but equally important, I will argue that our coping responses are seriously hampered by growing uncertainty about effects of climate change on our lives. And thirdly, uncertainty about the cooperation of fellow citizens. It takes two to tango, but billions to change the world. To clarify human responses I will discuss these three sources of uncertainty and two key factors moderating behavioral responses.

Responding to uncertainties

People, me too, dislike changes, leaving our comfort zones, changing the lifestyles that we learned to love and the goals we want to pursue. The transition needed follows a route with lots of unknowns, forcing us to deal with uncertainties in most domains of life. On the level of problem identification and acceptance: is there really a problem that requires such pervasive changes? On the level of coping: how to achieve this, what has to change? Is our standard of living at stake? Seeking changes, to our energy systems, for example, can be a daunting task for individual citizens. Moreover, effective solutions are not only dependent on the efforts of single individuals, but require massive cooperation and coordinated action. And they should be fair. Yet, it seems that governments tend to lose their steering role leaving the initiative more to private enterprise and citizen initiatives.

Should we be pessimistic? If so, you would not be in bad company. Are people hardwired to maintain their living environment? Humans possess features that do not foster confidence in human capabilities to deal with this problem. Evolutionary psychology teaches us that our ancestors were no noble ecological savages either; humans value their personal interests more than those of others; the present is valued over the future; humans are obsessed by social status (see Griskevicus, Cantu & van Vugt, 2012). But let us not be gloomy but instead explore ways to tackle these barriers.

Let's start with a look at basic human capabilities to cope with risks. In particular, it is the balance between ratio and intuition that needs understanding.

Balancing ratio and intuition

The magnitude of the climate issue and the pervasiveness of its consequences create challenges that go beyond the level of cognitive control for many human beings. Under such circumstances people use decision modes that do not require abstraction and reflection, but are based on the emotional system seeking simple signs and cues that carry meaning. Dual-system models explain social cognitions and behavior as a joint function of two interconnected mental faculties, each operating according to different principles. For example, the reflective–impulsive model (Strack & Deutsch, 2004) distinguishes between a reflective system and an impulsive system. The impulsive system directs behavior by focusing on seeking pleasure and avoiding pain. The reflective system features are complementary to the impulsive system, generating judgments, decisions and intentions. Together, they result in behavior. The impulsive system is always active and automatic, while the reflective system acts on intentions. Often, sustainable behavior entails a conflict between feeling and knowing; for example the excitement of fast driving against the intention of modest fuel consumption. In such a case, interventions are required that help people regulate their impulses. The reflective system has less power to suppress the impulsive system when available cognitive resources are reduced, for example under conditions of high cognitive load, a low capacity of self-control, or a positive mood. Interventions directed at changing behaviors should not only attempt to change people's reflective reactions but also their impulsive reactions, which is a challenge. Interventions should create the tools and situational circumstances that help to improve self-efficacy and self-regulation (Kok et al, 2011).

Moreover, many behavioral choices are controlled by habitual processes, linked to automatic responses and sparked by contextual cues. This insight that many of our behavioral choices are based on impulses, feelings and automated responses goes back to Aristotle who already distinguished between pathos, ethos and logos as the threefold foundation of human choice.

Is this a plea for policy making on irrational grounds? On the contrary, but I argue that emotions and intuitions form important human coping mechanisms to deal with the opportunities as well as the dangers impinging on humans in their living

environments. Successful policy will learn to take account of the variety of human response modes.

Trust- Is it mandatory that every citizen really makes an endeavor to consciously elaborate all risks being faced? One could reason that people face numerous risks all the time, which they cannot elaborate on, like in traffic, in working environments, natural conditions and not to forget at home, the top location of accidents. If the resources to do so are lacking, the risk coping strategy may be based on trust. Trust, call it a social emotion, enables people to rely on others, either human or system. Delegation of control is a necessity. In societies and communities lacking trust sustainable development as a group goal will be heavily hampered.

In sum, the human organism may react to uncertainty in distinct ways. The rational route is slow and taxes the cognitive system. It will be used, if personal relevance is high and the circumstances allow for it. If not, persons may rely on their quick intuitions, their feelings and routines to tackle ambiguity. Trust or distrust may replace informed decision making. Evidently, intervention designers should cater for these different coping strategies.

This brings me to the second key factor: the tight link between technology and behavior in dealing with climate risks.

Linking technology and behavior

Wouldn't it be great if the brilliant engineers of our world would just solve the issue silently, not bothering us with impingements on the lifestyles we love so much? I am afraid such a technical fix will turn out to be a dream. Rebound effects and lack of adoption hamper technical fixes. However, perhaps more than engineers have realized, technology could contribute substantially by influencing human behavior. Today, I want to elaborate on the critical roles of technology in shaping human behavior, emphasizing how much technology and human behavior are interrelated. And how unfortunate the split in engineering and behavioral policy approaches has been over the last forty years.

Let me quote Teddy McCalley's words in one of our joint papers: 'Since man first stood upright and struck a piece of flint to make a spark, the use of natural resources and technological development have marched hand in hand. As civilization emerged from our increasing control over nature, population increased and so, again, keeping pace, did technology and the use of natural resources (Midden, Kaiser & McCalley, 2007). The environmental impact of people, whether as individuals, households or societies, can be roughly assessed as a function of their numbers, their affluence and the technology they currently use (Ehrlich & Ehrlich, 1991). In that paper, also co-authored by Florian Kaiser, we distinguish four critical roles of technology concerning human behavior.

Intermediary role

First, the environmental effects of behavioral changes are dependent on the technology applied. Compare the same laundry done in an old washing machine against a highly efficient one. These intermediary effects of system use raise great uncertainty about the optimal behavior, for example, when to replace the washing machine for a modern one, considering the effects of production, use and disposal? Changing the technology means changing behavioral outcomes and thus behavioral decisions. This leads to the strategic goal of clarifying the most efficient options to enable individuals to make informed choices on sustainable outcomes.

Amplification role

Secondly, technology amplifies the effects of human behavior. Changing the technology means augmenting the scope of behavior. As an example, modern jets amplify our exploration scope compared to bicycles. As a side effect, human behavior gets progressively more consumptive as well.

The amplification perspective throws a new light on the adoption of new sustainable technologies and rebound effects. It emphasizes that the consumption of natural resources is primarily a side effect of human performance aimed to achieve other favored outcomes. As a result, producers and engineers who succeed in improving the resource efficiency of a given product are essentially optimizing an attribute of secondary significance to the user. These environmental benefits may easily be dominated by the primary purpose or attribute of the product. To illustrate, the Toyota Prius, a hybrid car, designed for its low fuel consumption and low emission rate, had a slow start in sales in the late nineties because it attracted mainly environmentally concerned consumers. It failed to satisfy primary consumer needs such as power and appearance. The next model improved on these drawbacks, which led to increased sales even among customers less concerned with the environment.

The amplification role affects the uncertainty of needs and value fulfillment due to sustainable technology. This leads to the strategic goal of enhancing and articulating acceptance and satisfying needs while seeking sustainable options. Sustainable innovations that ignore the prime value of products will tend to fail.

Determinant role

Thirdly, technology instantaneously shapes — affords or restrains — behavior without requiring any recognition or awareness on the actor's side (cf. McKenzie-Mohr, 2000). Otherwise, nobody would ever be baffled by sliding doors or a phone with a "mind of its own". Augmented technology deterministically facilitates or impedes people's behaviors (Tanner et al., 2004), regardless of people's intentions. For example, a high density of trash receptacles makes littering less likely for everyone, irrespective of people's tidiness because it is easy to do the "right thing" and throw litter in a nearby trash bin. In a similar manner the microwave oven paved the way for individualized eating patterns and so did the Internet for social networks that span vast physical distances (Midden, Kaiser & McCalley, 2007).

Technology also creates contexts in which habits are anchored (DeVries, Aarts & Midden, 2011). Habits are embedded in the products and systems we use and the buildings we live in. The goal of waste reduction may get activated at the moment of disposal. Activating environmental goals, norms or values through user interfaces gives them a greater prominence in the numerous decisions people make.

In sum, in its determinant's role technology offers guidance in behavioral decisions under uncertainty by automatic behavioral ignition, by value and norm activation, by obstruction or facilitation and by enhancing appeal. By designing or redesigning people's technical appliances, systems and environments consumers can be helped to develop a sustainable lifestyle, even beyond conscious attention.

Promoter role
This brings me to the fourth and final role in which technology actually helps to reduce the uncertainties of risk appraisal, risk coping and social cooperation that withhold people from moving. This is the role of promoter of sustainable behavior. I will use our own research to illustrate these efforts.

Improving risk appraisal

In spite of many campaigns launched by governments and NGO's (see Bartels & Nelissen, 2001 for an overview), it has been difficult to raise awareness for climate change risks mainly because they are abstract, distant and hard to imagine. Knowing the risk is different from sensing the risk. Novel virtual multimodal 3D-media, though, could improve communication by inducing direct sensory experiences that create "presence", the feeling of being there, and allow people to better conceptualize cause–effect relationships, such as how human life would be after serious climate change or climate disasters. Empirical research to date has found the effects of media from factors such as user-initiated control, interactivity, stereoscopic presentation, spatialized audio and haptic feedback (IJsselsteijn, 2004).

These technologies may help to better imagine the effects of climate risks and reduce discounting. Our early experimental evidence showed that video images with emotionally charged and personalized content stimulated attention and an information search for climate risks and coping options (Meijnders, Midden & Wilke, 2001). More recently, our research objective was to investigate how multimodal sensory stimulation by means of interactive 3D technology influences coping responses to virtual flooding risks in the Netherlands, which is prone to flooding due to extreme discharges from the rivers Rhine and Meuse. A lab experiment was conducted in which participants were exposed to a simulated dike breach and consequent flooding of their virtual residence. We tested the hypothesis that multimodal sensory stimulation by means of an interactive 3D simulation with spatialized audio strengthens coping responses compared to non-interactive 2D simulations. Results showed that exposure to the interactive 3D-simulation compared to traditional 2D-video, there was an increase in information searches related to coping responses, an impetus to evacuate from the virtual polder landscape and the motivation to buy flood insurance to protect oneself in the real world (Zaalberg and Midden, 2012). Results also indicated the role of a greater sense of being present in the virtual environment. In sum, these virtual experiences help to better grasp the scope and urgency of long-term risks and their consequences.

However, appraising risks is only the first step of fighting climate risks and diminishing the use of natural resources. Let us turn to the role of technology to promote coping behavior and reduce coping uncertainty.

Improving coping strategies

Since the seventies a great number of techniques to promote behavior change have been studied, including feedback, reward, goal setting, prompting and norm activation. Most traditional interventions to promote conservation behavior were designed to communicate with subjects in a one-way direction only. By contrast, modern intelligent systems enable two-way interaction between user and system, which allows for more precise targeting of tasks, adaptation and personalization. Interactive devices are still rare in the domain of environmental behavior. In my joint work with Teddy McCalley, we achieved energy conservation of up to 18% using washing machines with a user interface that allowed for interactive goal-setting and outcome feedback (McCalley & Midden, 2002; McCalley, 2006).

Intelligent agent technology can learn from users and is able to communicate on a personalized basis. Such tools are able to frame outcomes based on the user and the use context, help the user to articulate goals and support decisions on how to act. Recently, interactive systems with some of these features have entered the market. A good step further, smart agents, rather than acting as simple tools, adopt features of *social* persuasive agents (Fogg, 2003), thereby enhancing ease of interaction and influencing potential.

Obviously, persuasion is an inter-human activity in which social mechanisms like argumentation, praise, reciprocity, norm activation, authority and trust play a role. An abundance of studies has addressed how these factors influence persuasive interactions between humans (see for an overview e.g. Petty & Wegener, 1998). One may wonder whether similar processes would occur if the persuader is technological in nature instead of human. Interactive capabilities and human-like communication features (e.g. use of speech) allow artificial systems to take over the role of persuasive agents, at least at the perceptual level of the receiver. As BJ Fogg outlined, smart systems have specific advantages over human persuaders (Fogg, 2003). They can be more persistent (although this can be annoying as well), allow anonymity when sensitive issues are at stake, employ lots of data (to retrieve the right information at the right time), can easily be scaled and may gain access to areas where human persuaders might not be welcomed (e.g. bathroom) or are physically unable to go. At the social actor level persuasive technology

applies principles that humans use to influence others through social mechanisms like social approval, norm activation or social comparison. The seminal work on the media equation at Stanford by Byron Reeves and the late Cliff Nass demonstrated that people may react to computer systems in a way similar to how they respond to other human beings (Reeves and Nass, 1996). For example, people intuitively showed gratitude to a technological system after it provided a service just as when appreciating other humans. This work formed a basis for our research on persuasive communication and social influence by artificial social agents.

Social influence through smart systems

Basically, humans employ various strategies to influence others: social norms, conformity and compliance (Cialdini & Trost, 1998). A range of studies in our lab has demonstrated that persuasive technology that employs social influence strategies has stronger behavioral effects than when employing non-social tools (Midden & Ham, 2013). For example, experiments investigated the effects of social norm information provided by persuasive technology to reduce energy consumption. Participants were able to conserve energy while carrying out washing tasks with a simulated washing machine. During this task, some participants received social feedback, simple forms of social approval or disapproval, about their energy consumption from a robot (iCat, developed by Philips Corporation), able to show human-like facial expressions, speak and show lights on ears and paws. The iCat told participants for example "Your energy consumption is awful" when they set the temperature of the washing machine to a 90°C, indicating social disapproval. Other participants received feedback of a non-social nature either through an indicator on the display showing consumption in KWh or through a green and red light indicating good or bad performance. Results showed that the persuasive effects of social feedback were stronger compared to both types of non-social feedback, thereby supporting the notion that the socialness of the feedback by the agent made the difference.

In addition, these studies suggested that negative feedback - especially the social - leads to more conservation actions than positive feedback. This finding contradicts predictions form learning theory, but fits the theory that negative (social) events draw attention more strongly and are processed more intensely than positive events (Midden & Ham, 2014). Follow-up studies supported the hypothesis that while negative feedback from human sources could backfire, negative feedback from our social agents seemed less threatening and lead to more constructive processing than positive feedback only.

Of course, these findings raised the question of why these effects occur and which factors moderate them. Should effective persuasive technology have humanoid features that suggest it is capable of social interaction? How many and which social features are needed to make systems capable of exerting social influence?

Our research indicated that a humanoid face, body and speech are important social cues, which enhance the persuasiveness of technology (Vossen, Ham, & Midden, 2009). Interestingly, using multiple social cues, both speech and a humanoid embodiment, was redundant in activating a social mode of interaction with a persuasive agent. The human brain seems really sensitive to social cues that, when present, activate automatic processes that initiate social responses to the object providing the cues. This suggests that artificial agents should not necessarily be extremely human-like to be effective in social influence. The automatic nature of responses was also evidenced by the same effects occurring even when we deliberately emphasized the lack of agency and the machine nature of the system (Horsch, 2009; Roubroeks, 2014).

In sum, confrontation with social cues activated a social response irrespective of counter-information that the agent was non-human, just a machine, not in control and without agency. That is not to say that smart agents or robots are being perceived as identical to humans. No, they seem to take a novel position somewhere between objects and humans. Similar to perceptual illusions, one might understand this phenomenon as a social illusion. In spite of their understanding the system, participants could not easily evade the illusion. However, similar to virtual experiences in games, the illusion can be disturbed when the agent shows behavior that is incompatible with human behavior. For example, by showing gestures and speech which are emotionally incompatible (Ruijten, Midden & Ham, 2013).

Are these findings a plea for a near future in which humans are stalked by numerous artificial agents nagging for attention? Certainly not, overexposure, bossy language and inadequate behavior by agents will impede performance and acceptance (Roubroeks, 2014). But, if administered in sensible doses, artificial agents could make a substantive contribution to behavioral change programs.

Ambient Persuasion

Fortunately, persuasion is not limited to verbal communication, but can utilize other forms of sensory information like changing colors or sounds. While in many situations people might not be motivated or lack cognitive capacity to consciously process relatively complex energy information, it would be great if systems could inform users at an intuitive level, requiring little cognitive effort and attention. As studies on subliminal processing have shown, our perceptual system continues operating when conscious attention is low or even absent (Ham et al. 2009). Ambient intelligence, information technology embedded in the ambient environment, could provide new channels of influence through subtle environmental cues reflecting changes in form, movement, sound, color, smell or light. For example, a device called WaterBot aims to reduce water consumption by tracking and displaying information about water consumption at the sink itself (Arroyo, Bonanni & Selker, 2005).

Would this kind of ambient persuasive technology be able to influence a user without taxing cognitive resources (Maan et al., 2011)? We used interactive lighting feedback, depicted as a glow on the wall, about energy consumption task. The feedback not only saved energy but participants were easily able to perform a second task at the same time, whereas participants who processed feedback with kWh data could not.

What makes this type of feedback so fast and easy? Our research (Lu et al., 2015) demonstrated that in particular the link to accessible color associations, stored in memory, creates the differences. Colors may have strong associations; red indicating alertness or danger, in the context of green, and hot in the context of blue. Using colors that are strong and have a consistent association in relation to the task eases the processing of information feedback, while information that is inconsistent with pre-existing associations will inhibit processing. For example, colored light-glow feedback with a high association strength, like red for high and green for low energy consumption, worked better than a color pairing with weaker associations like yellow for high and purple for low energy consumption. Lighting mediated information, possibly in combination with ambient sound, offers great opportunities to support individuals or groups of users to achieve their goals while keeping cognitive efforts and disturbance at a minimum.

Trust and control: do we want technology to make the decisions?

My discussion of the four roles of technology suggests that both consumption and the use of natural resources are the result of the different ways in which humans interact with the technology surrounding them. Essentially, however, the availability of technical systems is based on human consent. An intelligent in-car navigation system can only produce the shortest route to a destination if the user is willing to use the system and rely on its guidance. Technological efficacy demands that the user is willing to delegate control to a system for carrying out a task. People seem motivated to reduce personal efforts by implementing automated systems to make life easier, reduce errors and improve safety. However, automation is not always beneficial for the user. Every user of an automatic system will experience system errors and the system's inability to deal with complex tasks. As a result the user may react by refraining from use at all.

Trustworthiness of a system will help a lot to achieve user cooperation. However, trust in systems is not always correctly calibrated (Lee & Moray, 1992). People may overestimate their own abilities compared to the system, leading to suboptimal choices, fatigue and human error. Alternatively, trust may be unjustified, leading to less vigilance for system errors and lower situational awareness, which reduces opportunities for user intervention. Peter de Vries showed in his doctoral thesis (De Vries, Midden, and Bouwhuis, 2003) how subjects developed trust or distrust in a system, using a route planner. It is not only the final result that counts. People make use of various cues in the interaction process, such as the dialogues and displays during the interaction, for example the displayed route map. Hence, acquiring trustworthiness poses a challenging requirement for product designers.

Linking to research on social agents, Frank Verberne demonstrated in his thesis how trust in smart automotive systems shows parallels with inter-human trust. In line with human trust, we found similarities in the effects of the goal, like car systems with similar goal rankings of speed and energy efficiency (Verberne, 2015). Furthermore, while facial and behavioral similarity play a crucial role in inter-human trust, this also appeared to be the case with trust in machines represented by social agent interfaces. Agents that looked similar, as a result of a 50% morphing with the user, were more trustworthy than agents morphed with

another person. Agents that unobtrusively mimicked the user's movements tended to be more trusted than non-mimicking agents.

Ethical issues of privacy and free choice may arise when users do not really have a choice of use but are ignorant, such as in the case that intelligent systems sense user behavior and act accordingly. For example, customers' purchasing patterns may be observed in a store and subsequently used to recommend customers by cell phone to buy sustainable products. Designing and constructing systems and interfaces that users trust and want to rely on will be one of the greater challenges requiring close collaboration between engineers and behavioral scientists.

Reducing social uncertainty, promoting social cohesion

Let us now turn to the third and perhaps most disturbing of uncertainties: we are not alone in this world. Climate risks are the result of joint efforts so solutions should be as well. 'Misery shared is misery halved'? Perhaps comforting, this thought raises major issues of fairness and effectiveness that can be indicted as a social trap. Let me just highlight some key notions of the related theory. Shared risks may stimulate feelings of shared responsibility thereby relaxing personal responsibilities. Uncertainty about the group performance and the contribution of others corrodes the motivation to contribute. Together they create a social trap by strengthening the tendency to optimize personal outcomes at the cost of collective resources. The disappointing fiascoes of international climate treaty negotiations form just one of these cases. These experiences point to the importance of fostering social cohesion as an overlooked tool to strengthen climate resilience. I was touched by a report from Chicago on the extreme sustained heat wave of 1995, which hit many local communities heavily, in particular low-income ones, leading to almost 500 heat-related deaths. Cohesive low-income communities, with high levels of community interaction and cooperation among residents showed the lowest numbers of fatalities.

A current positive trend of renewable energy systems is the emergence of local citizen initiatives that jointly invest in solar and wind systems. These community approaches are highly supportive of individual participation as they engage citizens, highlight group performance and make individual inputs transparent. Also on other group levels the reduction of social uncertainty could be promoted, such as on the household level and office level. These highly important group levels seem, however, to be largely ignored by researchers. These behaviors are often private and hence difficult to observe and measure. Persuasive technology could offer options to better assess these behaviors and facilitate communication in the group, thereby allowing more effective interventions. Research on group behavior in the lab and in the field demonstrated that feedback on group performance and comparative feedback on individual behaviors help to reduce energy consumption in those group environments (Midden, Ham, Kleppe, Kimura & Nakajima, 2011).

Conclusions

Technological systems alone will not save the planet. Sustainable technology is of great importance, but success will be dependent on human responses on all levels of engagement.

Behavior can be changed as many studies show. Behavior is not fussy or erratic. It can be specified, observed and measured. Well-designed intervention programs, based on good research, are able to induce behavioral change.

There is, however, not a magic button that can be designed to change behaviors. Humans are not machines but have their personal motives and needs and the capability of making their own decisions even when they seem inconsistent. Neither is there a silver bullet that can solve all issues at once. Behavior change basically entails a societal transition in which human mindsets, social systems and environmental affordances reconverge to a new balance. This requires not only time but a multitude of joint efforts at the engineering and behavioral levels.

Smart persuasive technology offers novel capabilities to make information more interactive, and adaptive to user and context. It offers users advice and feedback at the right time and place with the precision and consistency that cannot be achieved by human agents. Persuasive agents can encourage people and support their choices. In the hustle and bustle of daily life, ambient persuasion promises persuasive approaches that tax cognitive resources only slightly. At the media level, interactive virtual environments have the potential to provide persuasive sensory experiences and insights that are not achievable in the physical world.

Effective interventions must deal with the peculiarities of intuitive thinking. There are essentially two ways to address biases originating in the impulsive system: de-biasing and counter-biasing (Codagnone et al., 2015). De-biasing involves strategies to activate the analytical route of the rational system, necessary because adequate risk awareness is the foundation for change. By contrast, counter-biasing plays one impulsive system bias against another. Without pervading conscious awareness change could be induced while addressing issues of privacy and consent. However, persuasive technology cannot resolve all

uncertainty; it may empower people but not take over their decisions to engage. If empowered, citizens will respond, with social media enhancing involvement and awareness; so while government seems to be relinquishing control, the public and industry may take over the driving seat.

In conclusion, climate risks will not be solved with a few simple persuasive tricks. Persistent behavior change should happen and we had better do it effectively. Changing can be made easier, intuitive, less taxing and demanding, more pleasant and rewarding. Instead of preaching, users could be supported by smart systems calmly doing their work. The technology is available to counteract social traps and support social cohesion. The challenge is to evade reactance and annoyance responses, and to create solutions that are smart enough to adapt to specific needs and contexts, customized to acknowledge every person's unique needs, goals and competences. Ultimately, it is human beings who will face the future ahead. We cannot delegate all control to systems, either human or technical. In the end, it is our joint human responsibility. Our children and grandchildren are counting on us.

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Curriculum Vitae

Prof. Cees Midden was appointed full-time professor of Culture and Technology at the Department of Philosophy & Social Sciences (currently Department of Industrial Engineering and Innovation Sciences) on October 1, 1991.

Cees Midden received a degree in Psychology from the University of Leiden in 1976. From 1978 till 1987 he worked as a senior researcher at the National Laboratories for Energy research in the Netherlands specializing in the perception of energy risks. In 1987 he became Associate Professor at the Psychology Department of Leiden University. In 1991 he was appointed professor at Eindhoven University, specializing in the interaction between humans and technological systems. From 1993 until 2013 he chaired the group Human-Technology Interaction at TU/e. He served as dean of the department in 1994-1995. In addition, he served three periods as vice-dean. From 1993-1999 he served as the first chair of the TU/e program Technology for Sustainability. Prof Midden has been a member of various professional organizations such as the Society for Risk Analysis, the European Association of Social Psychology and the International Association of Applied Psychology.

His research focus is on the social and psychological factors of human-technology interactions. He has published extensively on environmental consumer behavior, on the perception and communication of technological risks and the adoption of technological innovations. Special topics of interest have been trust in sociotechnical systems, emotional and automatic components of judgment and behavioral choice, and the development of persuasive technologies and environments.

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