

# Emotional Drive

## Wearing your heart on your car

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**It is postulated that in the near future cars could detect and publicly display their drivers' emotions in real-time, by making use of an 'Affect Engine' along with colour changing paint. Moreover, using an implicit human-in-the-loop approach, and emerging communications standards, drivers perceptions and emotional responses could form an integral part of wider affect-based ad hoc vehicle-to-vehicle networks. Allowing participate in social emotional displays that interact with transport infrastructure to help to advantage, and so encourage, positive emotional states and interactions.**

*Affective Computing, Human Computer Interaction (HCI), Pervasive Computing, Future and Emerging Technology, Ethics, Society, Design Fiction, Speculative Design.*

### 1. INTRODUCTION

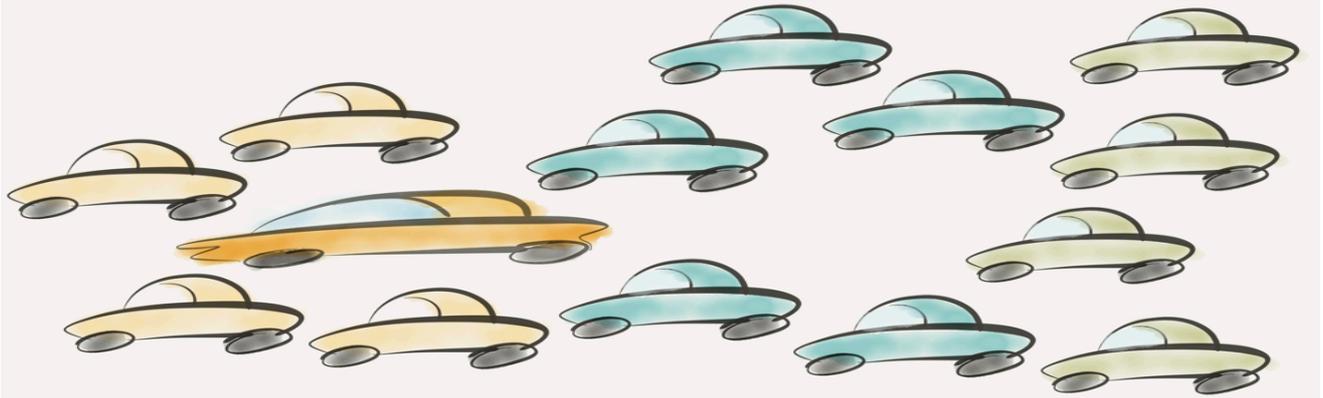
This paper looks towards a possible near future, when all but moderated recreational driving is allowed, and considers how human social values and emotional responses could play an essential role as part of the overarching interactive control system. This is a work of speculative fiction (Dunne and Raby 2013) that muses on how: recent experiments within the car industry, developments within computer science, and emerging social trends might influence our future interactions with cars, transport infrastructures, and with each other. This takes place in a context that sees the car industry beginning to explore the changing relationship between their products and the people who drive them, and who will be driven by them. What role might emotion play in our future journeys?

### 2. THE ROAD AHEAD

Having read the morning news, cleared my inbox, and taken time for to be mindful... I am bored. I place my seat in the driving position which signals to my virtual personal assistant that I want to take manual control of the car. Until now the autopilot has been navigating my car effortlessly along, in a river of, mandatory, white automated vehicles. After a brief but required set of safety assessments to ensure my competence to drive at this time – sobriety, alertness, and positive mood – control is approved. The car automatically segues to the far side of the

automated drive lanes and negotiates entry into the manual drive lanes. The bodywork of the car comes to life in an opalescent display of colour, to indicate to other drivers my intention to join them. Then, as the car passes through the access point, control is transitioned, verified and the autopilot slips into monitor mode. At that same moment, the Affect Engine launches, analyses my emotional state and the bodywork of my car takes on a vivid, joyful, yellow hue. It is a sunny morning, a favourite song is playing, and I am driving.

The cars around me each display their driver's current emotional state, a requirement of access to the manual drive lanes, after it was shown that monitored emotionally aware driving was of a low enough risk to be allowed for recreational use. Most are shades of yellow, orange or light green to show that their drivers are joyful relaxed, vigilant, and trusting. Then, just up ahead, a car quickly changes to the pale blue of distraction before drifting across lanes. The bodywork of the car next to it flashes a deep green, indicating the driver's fear. However, instead of the pale blue car turning deep orange to show that the driver has become vigilant once again, it instead turns pink and quickly the deep red of annoyance. Seeing this, a wave of purple ripples across surrounding cars, showing the disgust of nearby drivers at the aggression being displayed. The now red car begins to pulse white and black as its Affect Engine requests that the autopilot take control and manoeuvre the car, and its driver, back to the automated drive lanes until a penalty period



has passed. The cars ahead mostly return to a mix of yellow, orange and light green, except for a wake of green-blue awe washing across cars near an ecstasy yellow sports car as it speeds, politely, through the traffic.

### 3. UNDER THE BONNET

The above scenario while fanciful is rooted in technology and social behaviour that is either evident or emerging within society, albeit at an early stage.

#### 3.1. Affect Engine

The technology relating to Affective Computing has matured quickly, since first formalised by Rosalind Picard (1997). There are now a wide range of current and emerging technologies that show promise in robustly detecting and classifying human emotion using a variety of types of sensors. Notable examples of such technology are those by Llewellynn and Sorci (2011), McDuff, et al. (2016), and Microsoft (2017), which use facial expression for affect analysis. These approaches would for the most part be highly capable of operating within the relatively constrained environment of a car. Additionally, methods of assessing other measures relevant to assessing a person's competence to drive, at a given time, are also available. Work by Price et al. (2017) considers how to assess cognitive fatigue within a mobile setting, while taking surrounding physiological, social and environmental factors into consideration. The potential for this has not been lost on car manufacturers, such as Honda (2017) who proposed the NueV concept car with a proposed 'Emotion Engine' that is intended to analyse driver affect and, making use of an artificial intelligence, support the driver's emotional needs. Additionally, IBM have patented methods for determining when to transition control of a vehicle between autonomous and manual mode, or vice versa, based on an assessment of the relative competencies of the vehicle control system and those of the driver (Gordon et al., 2015).

#### 3.2. Implicit Human-in-the-loop control

Standards for vehicles-to-vehicle and vehicle-to-infrastructure communications already exist, such as IEEE 1609.0.2013 (2013). However, to realise the proposed technology it would be necessary to include *human-to-vehicle* communications within the overarching control system. This could take the form of placing a person's implicit recognition of behaviour and their resulting emotional responses at the heart of the system's sense, process and actuate control cycle. In this respect, sensing would take the form of the person's perception of the behaviours of other drivers. Processing could be realised through the combination of the person's implicit emotional response and an Affect Engine's analysis of that response. This process could perhaps be informed by a growing understanding of how various stimuli while driving can effect driver emotion (Hyundai, 2017). Actuation, publicly visualising the emotional response, requires the next piece in the proposed puzzle.

#### 3.3. Displaying emotion on cars

Interestingly, the potential to render human emotion, or other signals, on a car's bodywork is more advanced than might first be thought. An April Fool's Day joke by Peugeot (2012) captured the potential, both desirable and undesirable, of public emotional display on a car, through the idea of colour changing paintwork linked to a sensor. This concept was revisited by Lexus (2015) but this time for heartrate visualisation, and more importantly, the actuation phase was realised. They coated the panels of the car with an electroluminescent paint and then linked the panels, via a control unit, to the signal from the heartrate monitor. While only a single colour luminescent effect, this mechanism of controlling the appearance of a car's paintwork in response to biometric input, which could have been any human originated signal, was striking. It could also perhaps show the way forward for more complex visualisations.

### 3.4. Colour of emotion

Of course, the question must also be asked, what colour is a given emotion. The scenario presented earlier in this paper used affect to colour mappings based on Plutchik's (2001) wheel of emotion. This was as much for convenience as any other reason, given the likely familiarity of this coding scheme to the reader. However, it may be helpful to note that work by Terada et al. (2012) endorsed the appropriateness of Plutchik's scheme for use in visualising emotion on the surface of a colour changing robot. Regardless, the use of any mapping between emotion and colour is likely to remain subjective and culturally dependent (Hupka et al., 1997), and my, to a degree, need to be learned rather than anything more instinctive.

## 4. DISCUSSION

This paper offered a design fiction to help to provoke our "imagining and materializing" (Bleecker, 2009) of our potential future relationship with cars, transport infrastructures, and each other, in a future possible world where our emotions play a highly visible part of our human and computer interactions.

It has also hopefully shown that there is some emerging technical feasibility regarding how to realise such a system. As noted, the underlying standards for communications at the vehicle-to-infrastructure and vehicle-to-vehicle levels already exist, although they do not presently encompass considerations such as human emotions, or other human factors. The materials needed to actuate the display of emotions are available, although perhaps not yet at a practical enough level for mass market use. However, this is perhaps a simple matter of demand not yet being sufficient.

More relevant here, the technology needed to recognise human emotion is advancing quickly but, despite the generally constrained nature of driver affect detection in a car, challenges such as robustness in the presence of low and dynamic light levels, typical of night-time driving, could perhaps still present problems for computer vision based approaches. However, work in addressing such challenges is well advanced in relation to other aspects of driver face analysis, e.g. for fatigue detection (Ji et al. 2004) and for vigilance detection (Bergasa, 2006). Alternative approaches to sensing affect from skin conductance or heart rate, using sensors embedded in the steering wheel, in other controls, or worn by the driver, would likely provide a much less nuanced classification of affect. Moreover, as with all such sensors, these could also prove to be too susceptible to signal noise, in this case perhaps caused by the act of the driver moving their hands on the steering wheel. However, these are all active problems within a fast moving field of

research and solutions, in this case towards improved resilience to lighting conditions, will no doubt be devised.

However, the question quickly becomes "should you do it?", would anyone want to publicly display their emotions on the outside of their car? Perhaps we can look to current, restricted, public displays of emotion, and other values, that take place presently within society. Displays that come to mind are the use of emojis in online and written communications, Facebook *Likes*, and their more recent *Reaction* and *Feeling* tag additions, along with the less technological rise in the number of people with tattoos; and the growing acceptance of tattoos. More general public display, not restricted to emotion but perhaps also indicative of a more public self, can also be seen in the increase in photo and video sharing as a means of everyday social communication.

Notwithstanding this, the nature of the public display of emotion suggested earlier in the paper is somewhat different from today's practices. Perhaps the most significant difference being that we normally filter our emotional displays, for many personal and social reasons. To not simply remove this very natural filtering process but to then render our unfiltered emotions publicly and in a vivid manner would be a significant change in current behaviour. So, until some form of artificial affect filtering process is available, perhaps something subtler, and in keeping with current emotional communication would be an easier first step. Affectiva (2017), who produce one of the leading affect analyses toolsets, suggested that car manufacturers could offer dynamic emojis that indicate the driver's mood, in the form of a "real-time (emotional) bumper sticker".

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