Final report

Persuasive driving aid

TomTopportunities: Safety for Young Drivers

TU/e
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Client
TomTom

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Abstract

For the client TomTom, this FBP project aimed to design a product that actively engages to influence the behaviour of a car driver. This persuasion is directed towards safer driving through better understanding of the risks taken and it hopes to trigger positive effects resulting from this awareness. Focusing on safety seems a good choice in tandem with the focus on young drivers. These drivers face higher risks than other drivers for various reasons. This project proposes a persuasive robot linked up to a TomTom product, that warns ahead of potentially dangerous situations and gives the young driver feedback on performance. It does so by making a range of gestures appropriate for the conveyed messages. Research suggests considerable safety effects could be obtained using such socially embodied feedback.

Keywords: young drivers, safety, persuasion, affective technology

Chapter 1 Introduction

TomTopportunities is my Final Bachelor Project at Industrial Design. The project is set within the Automobility theme and aims "to investigate opportunities for exploiting GPS data to facilitate the driver's task and contribute to safe and sustainable driving," as lined out in the general TomTopportunties project description.

I've taken a more focused approach on designing a product or system that influences the driver's behaviour. This direction is better suited to my personal development plan and fits in with my intention to switch to the Masters course on Human-Technology Interaction.

Very densely stated, this project aims to design a product, service or both that actively engages to influence the behaviour of a car driver. This influence is directed towards safer driving through better understanding of one's own driving behaviour. The product thus makes the driver aware of less than ideal situations and hopes to trigger positive effects resulting from the increased awareness.

"A TomTom navigation device knows about the location of the car and has access to map information. Therefore, it could provide context-aware information to the driver," says the project outline. This project wants to differ by not so much giving factual information (such as where the nearest free parking is) but rather work on the experience of driving. It aims at one small but important part of the driving experience, risk perception. The amount of risk perceived to be involved in any given situation determines to some extent the decision that someone will make.

Ideally, the resulting product or service advices the driver on the risks taken or about to be taken in relation to the 'real risk'. This real risk should be derived from knowledge of the immediate environment, such the route taken, nearby crossings, speed limits, possibly accident data and the current movement of the vehicle. The advice intends to cause awareness and reflection on behaviour that ultimately leads to a safer driving behaviour. Apart from reaching this stadium of influencing behaviour, a major challenge will be to reach that while not alienating users for fear of loss of freedom and independence.

About the client **1.2**

In this project the client contact is mainly facilitated via TomTom's Automotive division, which focuses on in-dash navigation and car integration products. It stems from the initial project setup to develop concepts based on navigation and 'in-car knowledge'.

"TomTom is a digital mapping and routing company that focuses on car navigation. We aim to gain competitive advantage through superior products, a leading brand and a flexible production structure. We deliver Better Maps through a combination of our high quality map data base that is continuously kept up to date through input from our extensive fleet of surveying vehicles and our large community of users. We deliver Better Routing through the world's largest historical speed profile data base and our unique real time traffic information service. Together this enables TomTom to offer cutting edge navigation solutions that can be used on different hardware platforms."

"Products include Portable Navigation Devices (PNDs), line fitted in-dash navigation solutions and software for use on PDAs and smartphones. Through the Tele Atlas unit the company also supplies digital maps that enable routing guidance. In 2008, TomTom navigation products are sold in over 30 countries (and over 20 languages). TomTom has offices in Europe, North America, Asia and Australia. TomTom's products are mainly sold by retailers, who buy from distributors. Some products and services are also sold online. Tele Atlas provides maps including detailed street-level and interconnecting road networks for 80 countries."

(retrieved from TomTom.com)

Fig 1. TomTom company logo

1.3 Project goals

As said in the introduction, this project aims to design a product, service or both that actively engages to influence the behaviour of a car driver. This influence is directed towards safer driving through better understanding of one's own driving behaviour. The product thus makes the driver aware and hopes to trigger positive effects resulting from the internal reflection within the driver's mind.

This main objective can only be achieved by knowing what is behaviour, what could influence behaviour and how it could be done by a product that actively seeks to do so. This understanding is key for the project. Thus the first objective is to understand the psyche of a young driver, as far as relevant for this project. Second, the design needs take into account the preferences of users. In short, a good understanding of users is a sensible and important objective.

It's considered important (and besides, mandatory) to evaluate the design concept with users. Thus the creation of a working prototype is an objective. The prototype should perform as well as necessary to be able to evaluate a concept. It may mean multiple versions are to be built along the way, given the design phases. Following from this is the objective to perform user tests in a fashion that will help to evaluate a concept and help improve it, plus give an idea of the effect of behaviour influence.

Deliverables

Preliminary planning and approach: Planning should incorporate the phases that ideally co-occur with client meetings.

At the end of each cycle / phase in the design process: Design concept(s) ready for presentation and evaluation.

At midterm exhibition: A clear concept direction and accompanying relevant research. Ideally, this concept direction involves early mockups and ideally technology prototypes, both which illustrate and convince of the project direction.

At final exhibition: A well-defined concept that is built on relevant research conclusions and user evaluation. This concept is illustrated visually and in technology. Ideally both final form and tech prototype make one item, but this will depend on feasibility.

At (midterm) and final exhibition: Relevant and concrete story on how the project outcome can relate to business value and what the implications are for a business to incorporate such design (of course this does not stand apart from the conceptual work presented).

At both midterm and final exhibition: Report documenting the project and its separate phases, both hard copy and cd-rom. In addition, the cd-rom should contain the additional materials generated during the project (presentations, documentation and etcetera).

Process & Methodology 1.4

The project will work on understanding the problem space by researching the target group preferences, psychological and cognitive principles involved in driving and by generating concepts that help to shape understanding of the project. The text on the left explains my intended approach as outlined in my PDP.

Summarising I want to split the project into several phases. At the end of each phase the concept development and knowledge on the topic should have grown along, with tangible results that help to present, discuss and evaluate the process. Thus each phase leads to conclusions which form the starting point for the next phase. Figure 2 shows a schematic timeline of the process.

As stated in my Personal Development Plan I want to try and evaluate a different way of knowledge building, compared to a linear process of information gathering, settings requirements, conceptual development and refinement. One of the reasons is to find out if it suits me to work in a more parallel structure in which I set (intermediate) goals next to each other for different aspects. These are then worked concurrently, for example by using work blocks on each day which are used for the different aspects. It fits into the idea of using shorter design cycles, so after each cycle things grow but are not definite. These cycles then might help reflection for myself and with others. Thus the design process should reflect this way of working so it can be evaluated at the end of the semester.

The past year I've had a more traditional and theoretical training in human factors related subjects.

Now I'd like to apply this knowledge and analytical skills in a project setting. To make it concrete I will try to apply and transfer psychological principles into a model relevant for the project. One way can be to incorporate known psychological principles (identify them and try to apply in concept). Currently I believe I should pick one relatively simple principle (i.e. operand conditioning to influence behaviour) and try this with user evaluations. A measure for success would be evaluation of the application together with an expert on this topic. From there the appliance of this knowledge could be improved.

Another relevant aspect is the business value for the client. A concrete way is to look at the influence on the business chain through client and / or expert communication. This will have influence on the concept or communication of the design.

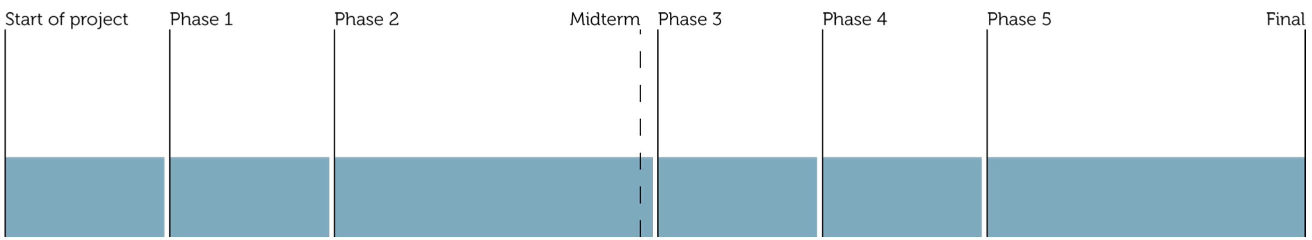


Fig. 2 - Outline of project with phases indicated.

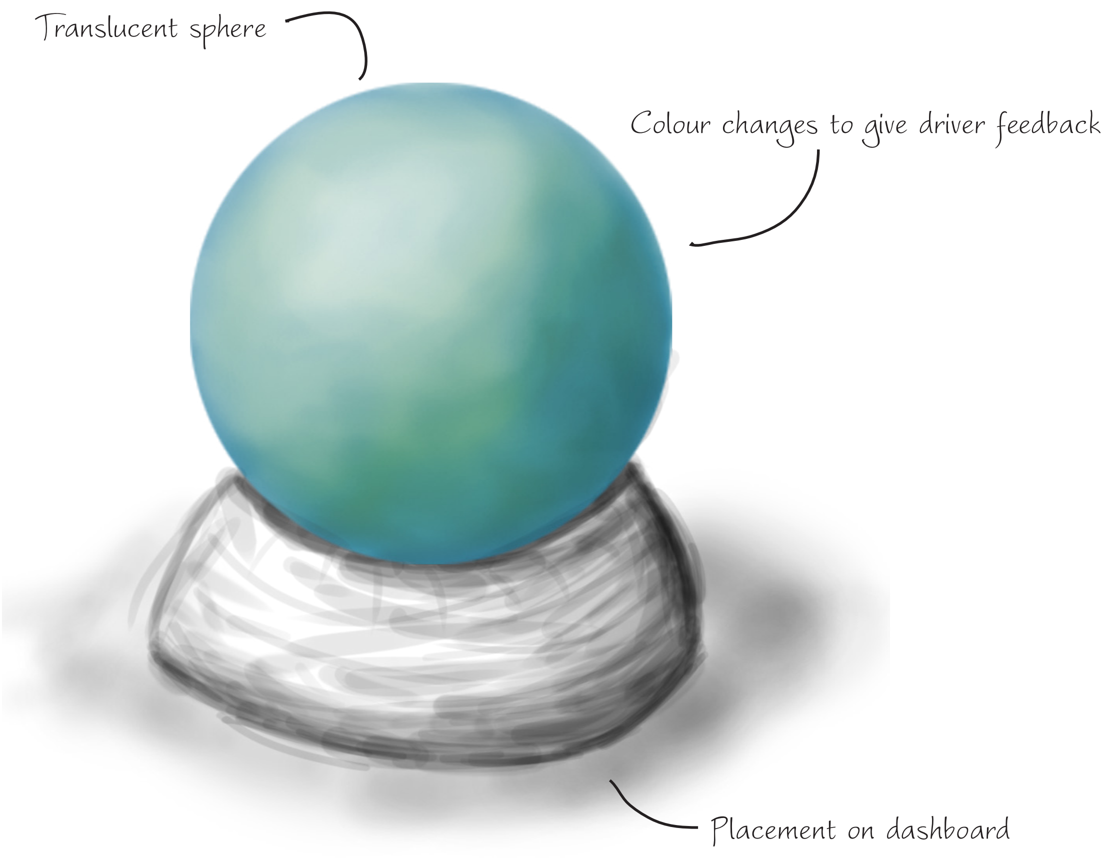


Fig. 3 - Quick sketch of initial idea

Chapter 2 First phase

The TomTopportunities project has a broad scope. It's therefore important for me to focus my efforts in one direction. Because of personal interests I've determined to focus on influencing behaviour of drivers. I'm interested in to see how a product could influence the thoughts and decision making process of people. I believe such persuasive technology as it is usually called provides a good opportunity for a designer to learn about how people interact with products and services.

In this first phase I've oriented myself on the various possibilities and narrowed it down to one focus group and behavioural task.

§ 2.1 - Choice of direction

Of course there are many situations in which human driving behaviour is less than optimal and there are many subcategories when it comes to drivers. Thus it is necessary to narrow down the opportunities to just one focus group and one situation. My approach has been to make a matrix of possible situations and groups of drivers to identify opportunities. For example, truck drivers and mountainous roads provide an opportunity to look at ways to let them have a safe decent without overheating their engines and brakes. Another example is business people and traffic jams. What if people could be convinced of driving at a lower speed well in advance, so congestion is less then when everyone comes to a complete stop? Each opportunity was scrutinised for relevance to my project goals, TomTom's strategy and for realism, since there are things a in-car device simply cannot know or do (at this moment or in the near future).

The most worthwhile direction that was derived from this matrix is the combination of young drivers and 'inappropriate approach of crossings'. Such inappropriateness could be driving too fast, uncertainty about who's supposed to give way to whom and inattentiveness (failing to recognise the situation). This focus would provide ample opportunity to incorporate the major objectives set for the project and it works on safety while driving. This beneficial role is one of the strategic elements of TomTom products, as stated on their website.

§ 2.2 - About the young drivers

The target group selected for this project are young drivers. These drivers are between 18 and 25 years of age. This implies they can only have acquired their driver's license a few years back, which ultimately leads to the fact that they're likely to be inexperienced drivers. The prime reason to select young drivers is that they are a high risk group, being much more likely to get involved in a traffic accident. The risks are especially high if taken into account the fact that these young drivers make far less kilometres than experienced drivers. In numbers: 20% of all accidents involve young drivers, while these drivers make only 8% of the total kilometres driven by the population (SWOV, 2008). This makes young drivers four times as likely to be involved in an accident compared to experienced drivers (SWOV, 2008). Basically, in this age group traffic is one of the most life-threatening things they could get involved in, according to the data the Dutch CBS agency (2008) provides on mortality and its causes (see fig. 5). Still the possession of a driver's license is highly in demand for it gives a young person more freedom to move around and venture out further away from home in ways other means of transport can't. The figures 4 and 5 on the next page indicate clearly the increased risk for the target group. The high numbers alone provide reason to focus on this group when dealing with safety. In some graphs the starting drivers (around the age of twenty) show up together with the elderly population. This elderly group is simply put more prone to age induced slips and mistakes, while being less likely to survive an accident. I deem this group less interesting for the project, because of the age factor. With young drivers positive effects carry on in the future.

For the Netherlands the group between 18 and 25 years of age make up about ten percent of the population at slightly less than 1,6 million people. For the whole Eurozone it implies roughly 32 million people.

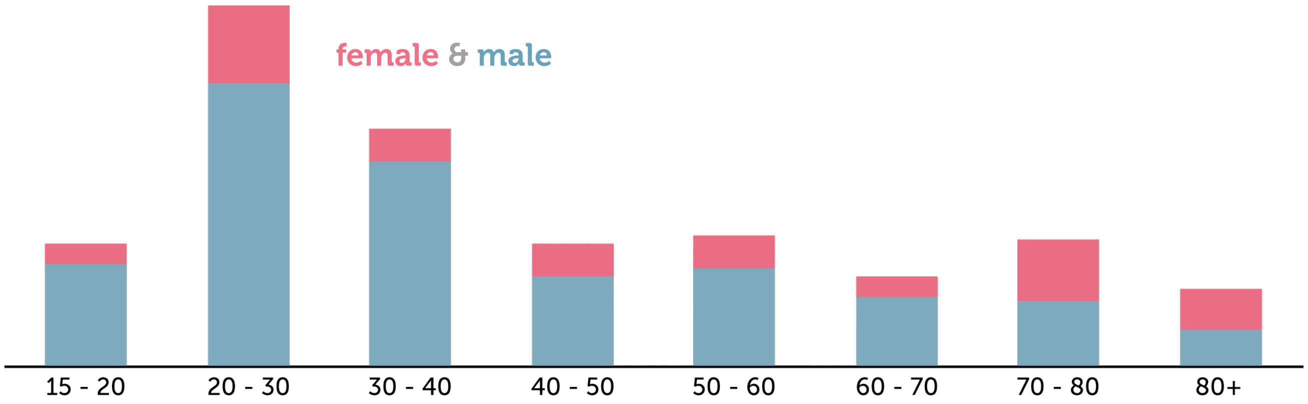


Fig. 4 - Distribution of traffic casualties by age. Actual numbers vary, but distribution is fairly similar in developed countries. Source: CBS, 2008.

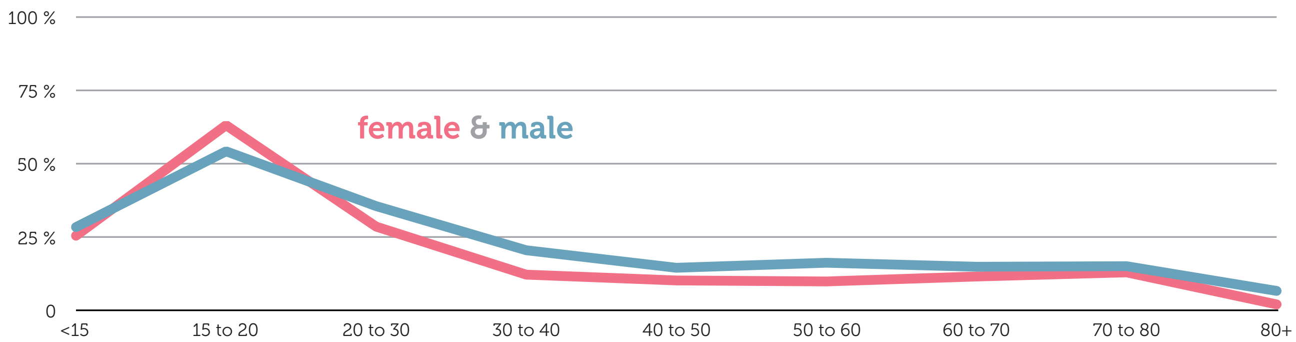


Fig. 5 - Traffic casualties as percentage of non-natural deaths by age. Source: CBS, 2008.

2 First phase

For young drivers it's not just inexperience that makes them more accident prone, otherwise this group would just differ in the amount of kilometres 'under the belt' and the amount routine performance and automatisms that come with experience. Young drivers differ by being young. This may sound obvious, but implies a different attitude to driving, adventurousness and life in general. Most salient with respect to traffic issues is the different (or lesser) risk perception and the lesser ability to deal with uncommon and complex circumstances. Combined with other factors such as late-night driving, explicit risk seeking, being distracted by peer passengers, it leads to a relatively high number of accidents for this age group (Vlakveld et al., 2008, via SWOV).

Figure 7 shows the relative incidence of accident causes for 18-24 year olds compared to experienced drivers of 30 to 49 years of age (Dutch Ministerie van VWS, via SWOV COGNOS database). Shown in figure 6 in is the fact that young drivers are often involved in single-sided accidents: 52% of all causes, compared to 26% for experienced male drivers. Female drivers show similar effects, albeit less strong (SWOV, 2008).

In short, the increased likelihood of accidents and the large impact it has on this demographic group, combined with potential for improvement makes the young drivers a good focus group because there's definitely something to gain in terms of safety and accident prevention. Plus, positive effects are likely to carry on when they grow older.

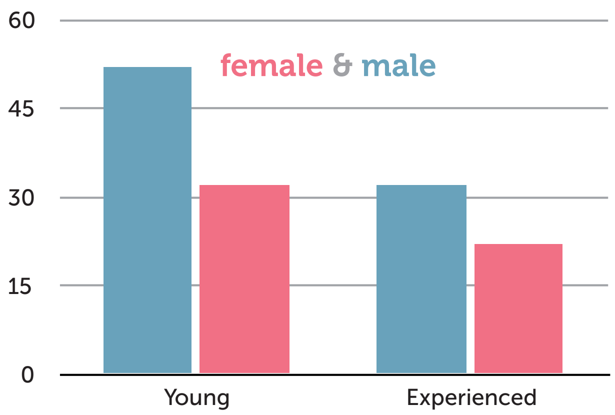


Fig. 6 - Percentage of single-sided accidents for young and experienced drivers. Numbers are clearly higher for males. Source: SWOV, 2008.

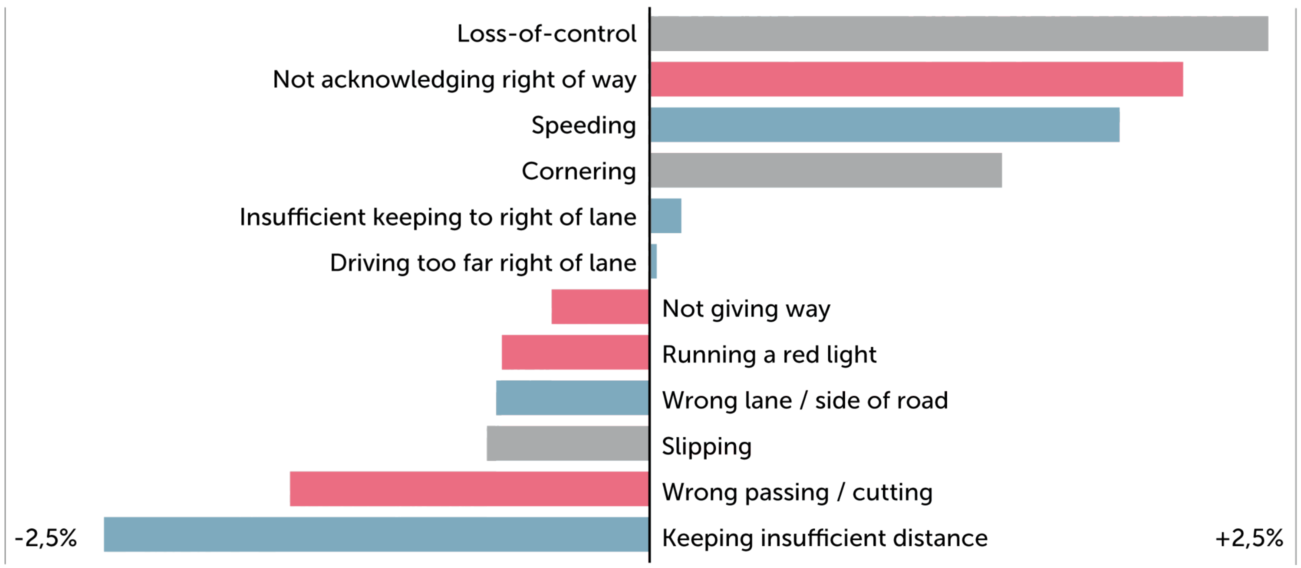


Fig. 7 - Relative incidence of accident causes of young drivers compared to experienced drivers. Colours indicate classification: grey for basic driving skills, blue for speeding & positioning and pink for decision making. Source: MinVWS, 2008.

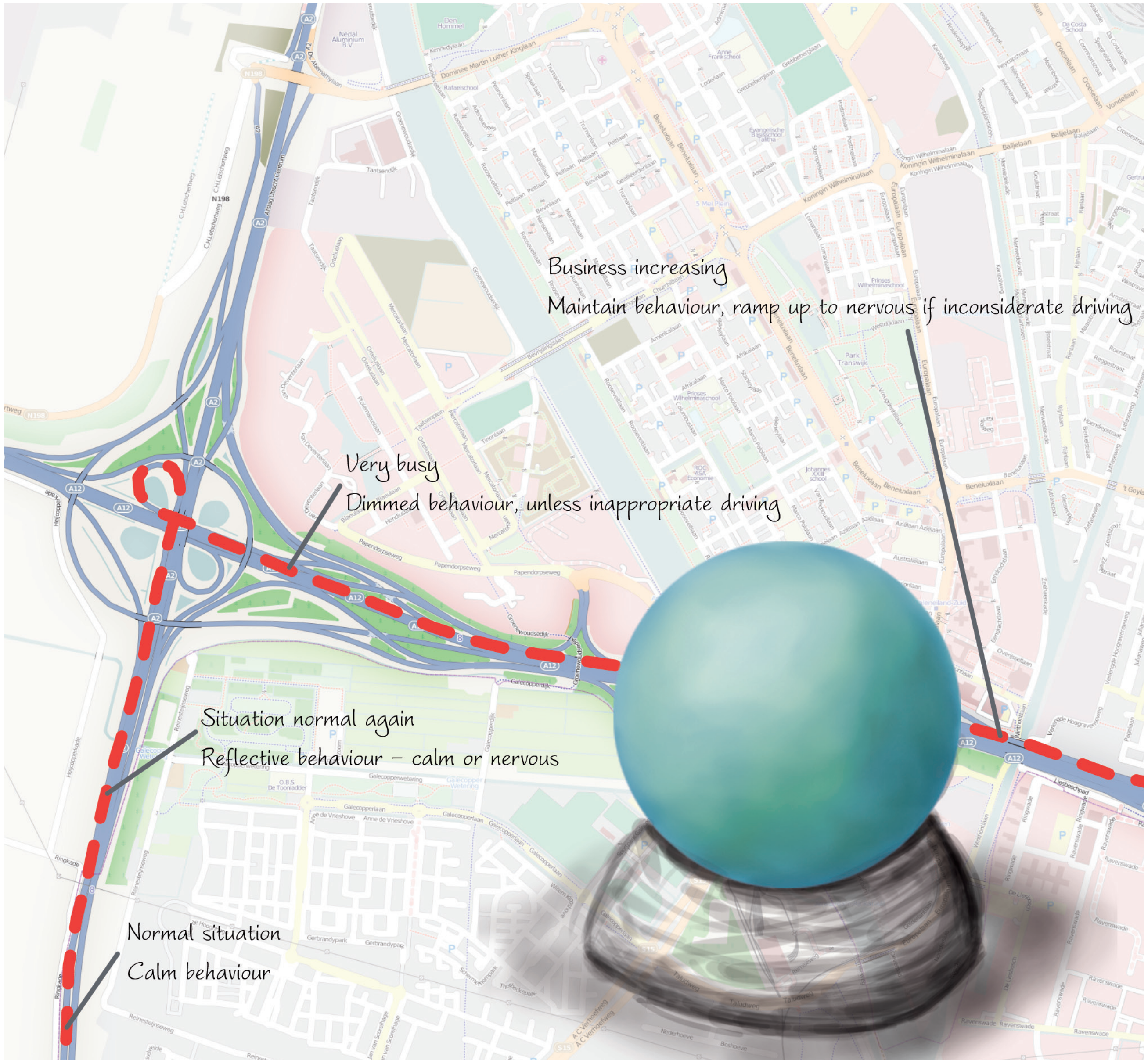


Fig. 8 - Early explanation of the idea with key moments identified on the map. Ball is supposed to change colour at these moments, depending on the driving behaviour.

§ 2.3 - First idea

Because this first phase was intended to quickly shape an idea of the total project, the preliminary findings and focus were used to generate ideas at an early stage. One idea was chosen and worked out further so it could be evaluated.

This idea consists of a translucent sphere (see fig. 3 and 8), to be placed on the dashboard, that will light up in different colours depending on the situation. The ball warns you of upcoming difficult situations, such as crossings and highway intersections. It does so dependent on the car's speed. If this speed is deemed too high the ball will change quickly between bright, conflicting colours (such as opposites like cyan and red). When the situation is approached calmly the ball will reflect this by having smooth transitions between less stark colours. To avoid distractions the ball won't do any of the flashy stuff while the driver needs to focus on the imminent situation. After having past the situation the ball could be used to display an evaluation of the driver's behaviour. Positive, calm colours would be used for good behaviour and hot colours for lesser performances.

§ 2.4 - Evaluation

The first idea proposed above is rather vague in the details, but shows enough of a possible direction to help in defining the next phase and consequently the project. It holds ambiguities which need be resolved, making the choices made for the project direction explicit. The next paragraphs talk through the most important items brought up for discussion.

What the ball idea does is mostly changing colour based on environmental cues. Just colours that sweep are not so informative though. It's actually highly abstract and more of a sign language than clear advice. This does have an upside to it, as it's less direct and less likely to be seen as outright negative criticism.

This first orientation learns me that I have no desire to make something ambient without concrete meaning and relevance. At this point I assume young drivers are better helped by a more direct and concrete design. Thus in next phases concept development should aim towards more concrete solutions to the issues at hand. Ideally a design stems from a clear principal to get a better fit between situations and persuaded behaviour.

A related finding is that the idea discussed here tries to do a range of things depending on the moment. A concept shouldn't do all kinds of stuff, at least not within this project's scope. It is better for the process to focus on one aspect of the driving to influence. Now it worked on speed, cornering and handling crossings, which is (roughly said) together with checking other traffic the complete driving experience.

This and other ideas generated show me the desire to do a physical product if possible, for I believe that brings with it more interactive possibilities. The current idea is not interactive. I think that an interactive product is better able at establishing a dialogue with the user and thus is better suited for its persuasive goals. This potential now goes unused.

§ 2.5 - Key findings during this phase

Focusing on safety is a good choice in tandem with the focus on young drivers. These drivers face higher risks than other drivers for various reasons. Risk perception is a major issue, worth further elaboration. Driving speed, cornering and handling complex situations are the major targets. From an initial idea development phase it can be concluded that in the next phase concepts should focus on one of these. Further it is believed that a more interactive approach could be worth exploring.

Chapter 3 Second phase

The objectives for this longer phase are to deepen the understanding of the target group, the psychology behind the behaviour I'd like to influence, as well as a higher level of concept development compared to the previous phase. Simply said the level goes up on all facets. At this point technology is deemed less important since not definite direction has been found, though it's likely to start playing a role nearer the end of this phase. During this phase external evaluation has become part of the process, via presentation meetings, initial talk with experts and an online questionnaire sent out to the target group. But let's start with the deepened research ...

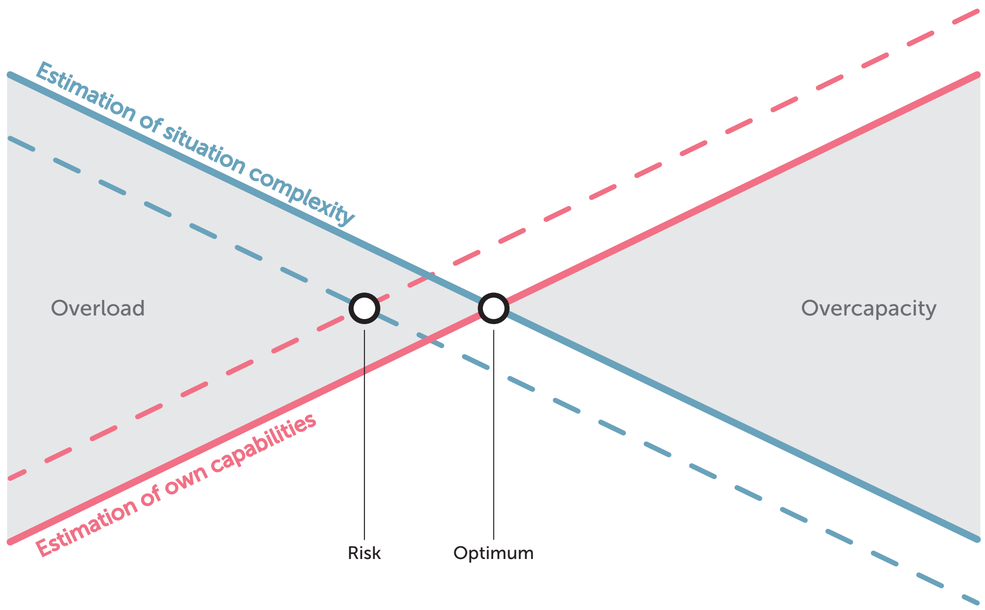


Fig. 9 - Visual model of risk perception and traffic complexity. If a given situation is more complex than one's capabilities can handle there's a large risk of failure and thus accidents.

§ 3.1 - About driving

What is actually driving? According to Wickens et al. (2004) “three levels of activity describe the complex set of tasks that comprise driving - strategic, tactical, and control. Strategic tasks focus on the purpose of the trip and the driver’s overall goals. ... Tactical tasks focus on the choice of manoeuvres and immediate goals in getting to a destination. Control tasks focus on the moment-to-moment operation of the vehicle.” The driver is constantly adjusting her car’s speed and position as to optimise the fulfilment of the strategic goals. Hereby they need to weigh two important things against each other. Again in Wickens et al.: “Productivity involves reaching one’s destination in a timely fashion, and safety involves avoiding accidents.” These two elements compete and hence the driver has to make a trade-off.

Going deeper into this matter we can say that driving consists of perceptual processing, cognitive processing and from there decision making and control processing. It can be argued that perceptual and motor issues are not the key problem for young drivers, but the other two (cognitive processing and deciding) are. Driving is inherently a multi-tasking and multiple modality activity, part of which is automatic response based on learned abilities. Part of the reason why young drivers have a relatively high change of accidents is because such automatic responses have not fully formed. Partially this comes from experience and partially it depends on being able to recognise the risks involved in a situation.

A key element during such multi-tasking is workload. Usually the driver’s workload is well below the threshold of what people can handle, but certain unexpected events that deserve attention can quickly change that. This is especially true for driving in a crowded environment. Environmental and psychological stressors can also complicate the perceptual and cognitive abilities (Wickens et al., 2004). I assume that most people, even inexperienced ones, will intuitively know the effects which are performance degrading. After all, car driving is basically controlling a machine based on cues you get from being aware and attentive. If you’re not attentive, you can’t be fully aware but rather assume certain situations to be one way or the other. The response might be inappropriate with potentially catastrophic results. Again, failing to comply with the situation may be one cause of the young driver issue.

§ 3.2 - Risk perception

The cognitive and decision making theory discussed in § 3.1 hint at one important part of the driving experience, risk perception. The amount of risk perceived to be involved in any given situation determines to a certain extent the decision made.

For example, when driving on a mountain pass with no fences near the side of the road, the perceived risk involved with speeding through corners is high. Nobody wants to fall into a ravine since it’s highly salient such a fall is deadly. Therefore a driver will choose not to speed through corners. Situations are often far less obvious and clear-cut as in this example. Mostly traffic situations involve less obvious risks as falling down a ravine. So the risk perception should be more finely tuned. This tuning is for various reasons less than ideal with the target group chosen for this project. Risk perception appears to be a major factor (Vlakveld et al., 2005).

When talking about risks there are two important measures, one being objective risk (the real statistical chance) and subjective risk, which measures the perceived risk. Often these are not equal. In general people tend to overestimate small chances and underestimate large chances, an effect named inproper risk calibration (Hardman, 2009). This explains why people accept common risks (speeding) but fear unlikely ones such as falling down a cliff.

§ 3.3 - Other psychological effects

Apart from usual decision making effects that may undermine safe driving behaviour (see Hardman and Wickens for an overview), young drivers tend to overestimate their own capabilities. It is better phrased as follows: they do not see the risks and thus conclude they are well able to deal with the situation. They also tend not to integrate past negative, thrilling experiences such as near-crashes in future decisions. The usual explanation for this is the positive evolutionary effect risk seeking has. Young people have to experiment to find out what works for them and they shouldn't give up after a (near) failure. The human brain and emotional system are tuned to this and it's all very handy when learning how to deal with killing wild animals, but less so for things that can kill you rather quickly upon mistakes. This risk-seeking effect explains to some extent why young males show higher accident rates: girls have their sensation seeking peek before they are allowed to get a driver's license (around the age of 16, and they are less sensation seeking in general) (Vlakveld et al., 2005). Of course, this effect sees large individual differences but in general most young drivers show this effect.

So I identified a lesser workload capability (due to cognitive effort required, compared to automatisms for experienced drivers), inproper risk perception and possibly overconfidence as the major underlying causes. Figure 9 shows these findings visually in a hypothetical model of risk calibration and driving risk.

Ideally then, the resulting product or service advices the driver on the risks taken or about to be taken in relation to the 'real risk'. This real risk should be derived from knowledge of the immediate environment, such the route taken, nearby crossings, speed limits, possibly accident data and the current movement of the vehicle. The advice intends to cause awareness and reflection on behaviour that ultimately leads to a safer driving behaviour. Apart from reaching this stadium of persuasion, a major challenge will be to reach that while not alienating users for fear of loss of freedom and independence.

Any effects that my design may have on safe driving could be confounded by findings that people tend to act less safe after having invested in it, even though this is completely irrational (Hardman, 2009). I deem it relevant to mention these effects as these may influence potential use of a safety advise system. This effect may or may not apply here even if it does in a similar study such as Midden & Ham's (2009).

A positive finding is that self-assessment is greatly improved if timely and good quality feedback is given (Hardman, 2009). It also gives less room to hindsight bias, the effect that in hindsight people tend to reinterpret their earlier thoughts to be closer to the later outcome, which makes the outcome seem more likely and less avoidable (and thus less reason to change decisions next time).

§ 3.4 - Current state of driver's licenses

Clearly this project is not the first attempt towards safer driving for young drivers. The most obvious item is the driver's license. In recent years a range of changes has been made in order to persuade the fresh drivers towards safer and well adjusted driving. Most notably in Netherlands was the introduction of a points license earlier this decade. It implies that for the first five years of possession a driver would lose the license after three mistakes have been recorded. But changes are very slim a driver ever gets caught, so it's not effective to reduce problems. The government now tries to aid the recognition of difficult situations by including this in the theoretical exams. But a Dutch traffic psychologist goes even as far as proposing young drivers shouldn't be allowed to drive at night or with peers as passenger, since only that would help.

Recently discussion flared up over letting younger people gain experience in the presence of an experienced driver. Seventeen years olds can thus gain driving experience. First experiences with this seem positive but it remains to be seen if this becomes common practice (SWOV, 2009).

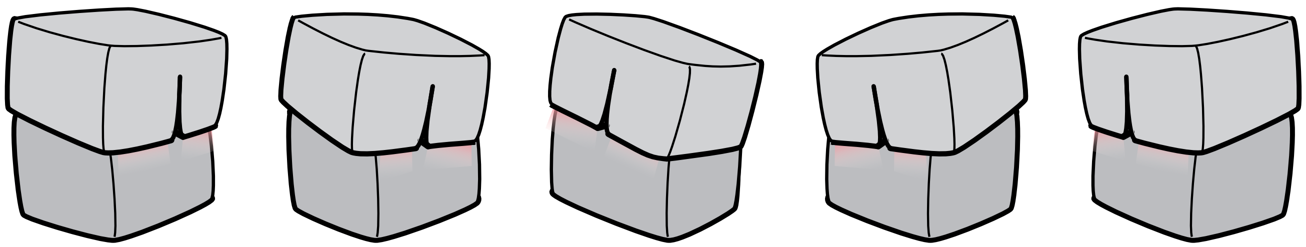
§ 3.5 - What others are doing

In terms of actual products that try to improve safety there are a few notable developments. This isn't meant as a thorough review, rather an overview. Car manufacturers work hard on making cars safer in case of accidents, but developments towards helping the driver prevent them are fewer in number. But newer, mostly high end cars are able to display maximum speeds and prevent the user from breaking these. This prevention can be done via audiovisual signals or by actively preventing the throttle from being pressed deeper. In this light it's worth to note that most navigation systems, be it from TomTom or otherwise, are aware of the speed limits and can warn accordingly. It can be argued that the often simplified view of the situation that a navigation system provides adds to the comprehension and safety (TNO, 2007).

Next to various research and field studies that are done on so-called Intelligent Speed Advisory systems, the BijRijder concept deserves a mention. This system consists of an artificial bee that is mounted in view of the driver and responds to the driving style by making noises and flapping its wings.

§ 3.6 - Concept development

While gathering knowledge as described before in this chapter, ideas were generated and from those ideas three concepts were worked out as a means to solicit feedback and help the decision process. These concepts improve on the criticism from the previous phase as well as incorporate the research findings within this phase. On the next pages the concepts are described, after which an evaluation follows.



Persuasive Agent is not on scale, real version would be smaller (less obstructing the view)

3.7 (1) Persuasive Agent

Overview

Young drivers are inexperienced and are still busy to learn to recognize traffic situations in terms of risk and good behaviour.
The object proposed here tries to help reflection on behaviour by communicating emotionally.

How it works

This concept uses a robot-like driving companion to give feedback on handling situations. For example, when approaching a crossing very fast the robot may look away, supposedly feeling endangered. Its behaviour provides a 'peer' review, helping self-reflection. The intention is to influence risk calibration positively.

The object is an abstract creature that's able to move and thereby display non-verbally like living creatures can. The emotive communication is dependent on the risk supposedly taken by the driver, as derived from map-sourced knowledge.

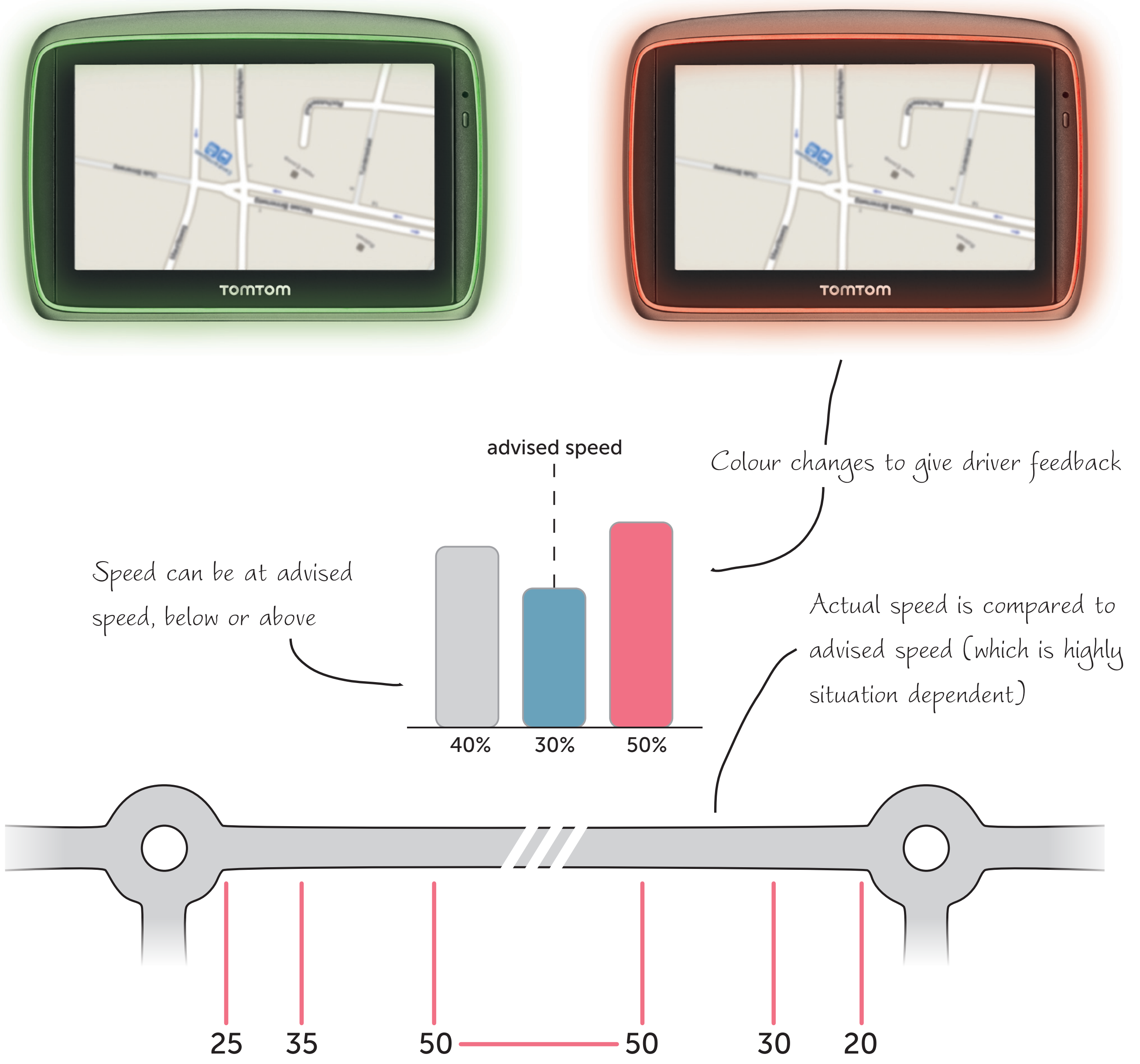
Speeding Awareness (2) **3.8**

Overview

One of the common problems with young drivers is speeding. Whether it's because of risk seeking or simply failing to appropriately judging the risks involved, there's reasong to make drivers aware of their attitude towards choosing speed.

How it works

The concept system logs speed and gives the driver feedback on appropriateness of the chosen speed. A driver can either drive at the advised speed or below or above this speed. The graphic feedback will show this, not only to the driver himself, but to the passengers (peers) as well. Placement should be a highly visual location in the car, such as the casing of a PND. Making the speed preference highly explicit can lead to a motivation to improve one's behaviour, also due of peer pressure.



3.9 (3) Speeding Awareness

Overview

Young drivers' traffic insight can be inadequate for various reasons. This makes self-reflection difficult since it's often not clear what makes for the lack of insight.

How it works

This concept tries to give insight by registering situations that were difficult or risky. Such 'tagging' can be done by the product and by the driver herself. These situations are then given for review after driving, so the driver becomes aware of areas for improvement.

The situations serve as evidence for reflection on the apparent behaviour. Ideally this reflection will lead to a personal motivation to improve.

§ 3.10 - Stakeholders

Figure 10 (on next page) identifies the stakeholders for this project and their incentives (derived from mission statements, survey info, interviews and where missing my own interpretation). These stakeholders are possible go-to sources during the project and will help to develop a good business value proposition for my design. It should deliver value to the consumer of the product and of course someone has to pay the party that brings the product to market.

§ 3.11 - Potential buyer interest

Why would young drivers be interested in buying something like this? At first this may seem doubtful, because it's a product that encroaches on the newly found freedom of driving. For them there may be a range of benefits though. It is a way to show responsibility to their parents and peers, and for those parties it can be a gift to stimulate such responsibility. It will help them improve their driving skills. Reasons against it are that people don't want to feel patronised and parents may not want to go that route either. Another likely reason is that people might not see a concrete value in the product for themselves.

When looking at it from a broader perspective it could be a tool to check upon the young driver. Parents could state their kid can't take the car without it. An insurance company could use the generated data to adjust its fees, although that brings in Big Brother and its nasty smell. Similar things are possible if obtaining a driver's license will include a period of driving with experienced drivers who are not the driving instructor, as it is considered now (see § 3.4).

Parents
- protect child's safety
  - reduce accidents
  - aid to risk awareness
- grow trust in child's driving
  - aid child's responsibility
  - accept child's freedom
- protect own car from damages

TomTom
- generating profit
- positive image
- beneficial role
  - aid safety
  - aid comfort
  - reduce distances driven
  - reduce effect of traffic jams
  - reduce fuel consumption

Friends
- experience freedom
  - no more mama's little child
  - assume responsibility
  - seek trust
- self-expression
- go well with friends

Young drivers
- experience freedom
  - no more mama's little child
  - assume responsibility
  - seek trust
- self-expression
- go well with friends
- learn driving
  - lesser risk awareness
  - mistakes are part of process

Police
- governing rules
- smooth traffic flow
- safe traffic

Driving instructors
- aid to safe traffic
- aid risk awareness
- reduce slips and mistakes
- positive image
- generating profit

Government
- reduce accidents
- reduce social losses
- moral responsibility to civilians

Science

SWOV
- gathering knowledge
- advisory role

3VO
- safe traffic

Insurance companies
- generating profit
  - reduce risks and costs
- positive image

Fig. 10 - Stakeholders and their primary interests in relation to safe driving.

§ 3.12 - Target group feedback

Last but definitely not least I will discuss the efforts towards understanding user views on the matter. The primary means of getting there was done via an online questionnaire. The main questions I wanted to answer were the following: Which risks are they seeing now and to what extent? How do they try to prevent risks now? What is their attitude towards comments on driving style? What is their opinion on advisory systems? Why would they be positive or negative in relation to such systems?

I'll discuss a few of the preliminary findings. See also appendix B for the survey itself. At this moment [October '09] the results have not been analysed thoroughly to do a complete discussion here. As things stand now, 92 people have completed the survey, which is reasonably large to take the results as representative of the target group (83 out of 92 are between 18 and 25 years of age, 65% is male). Of the respondents 75% owns a driver's license. Most respondents say owning a license it is important to them and notably, of the non-owners every participant would like to own a license.

Most drivers indicate that they feel they are safe drivers and that they have good awareness of the risks involved (compare this to the two figures on this page for a discrepancy). However, 54% responds that they do not worry about such risks while driving, while they seem more likely to worry about this in general (for example as a passenger). I assume the feeling of being in control might be of influence, so that it makes you feel safer (see also figure 12 for the same effect).

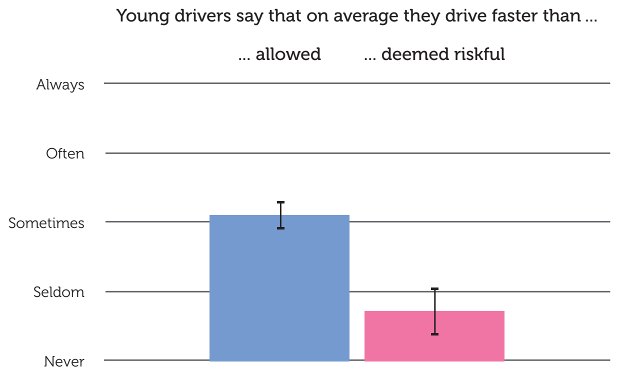


Fig. 11 - Survey response indicates a discrepancy between allowed and safe speed. Brackets indicate 95% confidence intervals.

When asked about how often they are fully aware of the correct right of way, about 31% responds they're always aware and 56% most of time. Likely a 1 to 5 scale (ranging from never to always) is ineffective to get the subtle differences between most of the time and always.

Questions about the preference for an advisory system reveal that none of the proposed kinds of advise are waved away completely (fig. 13). It's no surprise that

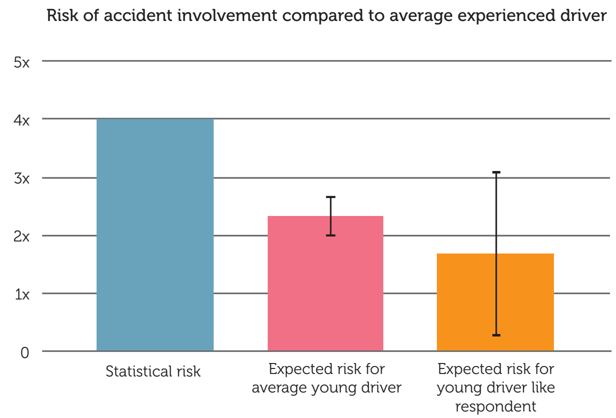


Fig. 12 - Respondents were asked to indicate their driving risk compared to an average driver under average circumstances. Results show a too low estimation compared to the statistical risk. Brackets indicate 95% confidence intervals.

route and traffic advise reign with both around 95% of the respondents expressing desirability. With regards to this project topic around 50% calls information on right of way desirable. Maximum speed info gets a good 60% positive response, while safe speed advise sees only a mere 30% positive response. Advise on cornering is deemed unnecessary by the majority, while there are almost no negative responses to advise on unsafe situations. A bit contradictory to the previous item is that the majority thinks feedback on taken risks is undesirable.

Why users express their opinions the way they do requires deeper analysis. To some extent the survey requires the respondent to imagine a system and base their opinions on this imagination which may differ for everyone. I assume that advisory feedback that helps global goals is more welcome than criticism on the methods to achieve these goals. Also at first glance it seems that advise beforehand is more desirable than feedback in hindsight. Luckily most respondents think such a system can help them in advance and can be of use. So there is a positive stance, depending on what the system does.

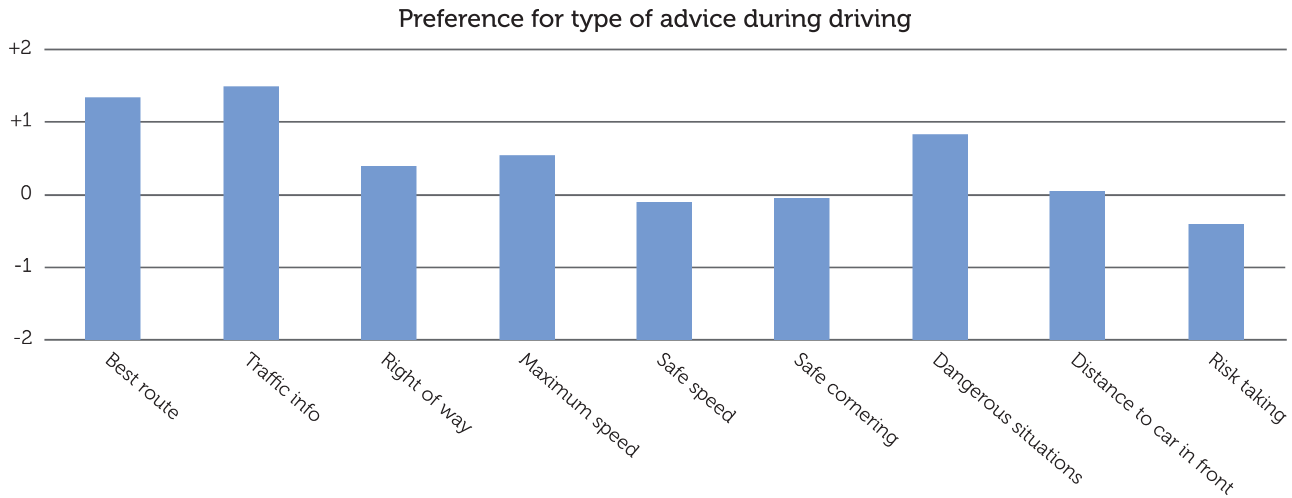


Fig. 13 - Respondents were asked to indicate their preferences for different kinds of advice during driving. Shown here are the averages of the responses. Scores below zero are dismissive, above appreciative.

§ 3.13 - Evaluation

This phase has seen deepening of the research up to a level where I believe I know enough about driving as a task. Things that remain to be investigated are persuasion related. What ways will work and in what way? The concepts proposed try different directions and the survey has helped to shine a light on preferences. But what's missing currently is a principle that guides the interaction between concept, persuasion and user. This is something to consider for a next phase. Also, I still believe the concepts don't use the interactive potential discussed earlier. These issues may be combined.

As discussed with René de Torbal in relation to his BijRijder concept (explained earlier) it's vital to make the resulting concept unique, so it sets itself apart from any competition. A good way of doing is to leverage the environmental knowledge a product can derive from the coupling with TomTom's data on maps, traffic intensity, in-car systems and such. Thus future concept development should take this into account, as it's also related to the business case. After all, a unique product may draw in customers.

After two presentation sessions the concepts were commented on. The major questions were aimed at desirability and likelihood of use. On behalf of the client there was criticism on incentives to pay for such a system and the possibility of self-selection (reckless drivers wouldn't be interested and thus not reached). Another issue the standalone character of the robotic agent. Unless there's good reason to do so, it makes things more complex. In further concept development this needs be addressed. Further feedback from the client was solicited, but not yet available [October '09].

§ 3.14 - Key findings during this phase

The direction taken is clear, with arguments that back it up. The focus is strictly on young drivers and acute feedback aiming at risk awareness. Research findings indicate importance of risk assesment processes and the insufficience of this seen with young drivers. The group itself was consulted via a survey. Three concepts were proposed to address the project goal. The concepts do not provide a solid case yet, which needs refinement. Foremost, the concept direction should be focused towards one or two of the concepts in the next phase. Models and mock-ups will help to discuss ideas with experts and users.

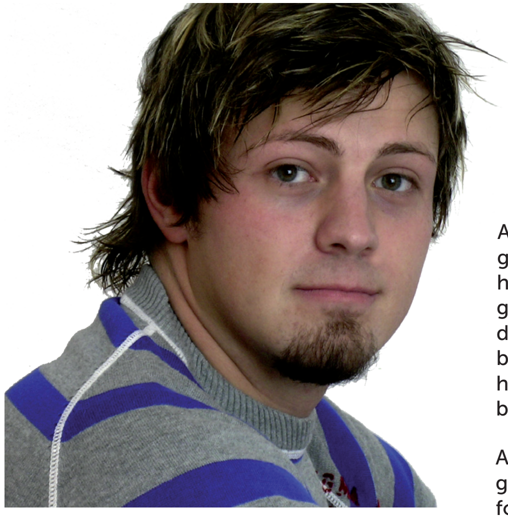
§ 3.15 - Concept choice process

Concept development has been largely orienting. Now the time has come to make a choice and iterate further from there. Appendix A includes a matrix that compares the three concepts of this phase, based on various criteria. These criteria are based on information stemming from literature research, a user survey, comments received from potential users and personal development goals. Some are not yet relevant of filled in because information is lacking. From this matrix it follows that there is a preference towards the first concept. But the second is in its own way similar in goal, thus it cannot be put aside without another look. Basically just the method of expression differs.

The user survey, also discussed in § 3.12, led to the following conclusions. The target group says they see benefit in a system that can help to interpret a traffic situation and conversely respondents indicate they're not convinced that advice in hindsight will aid their driving. See also appendix B for a full rundown of survey response. Again, the Review concept matches the least with the conclusions, because it is evaluative in nature.

Short talks with young drivers (a.o. during the midterm exhibition) suggests a preference for a 'communicative' solution, one that appeals beyond just the factual. This appears to match with the hypothesis that persuasion works better with social incentives. I state it as hypothesis because it's actually the subject of a large body of research. Among others, Midden & Ham (2009) have found that it (very likely) holds for the purposes of this project if pursued with the persuasive agent. The idea is that a robot is seen as social actor, "as able to make an independent value judgement" (Midden, Ham, 2009).

Based on these observations the persuasive agent becomes the focus of attention, with the speeding awareness seen as second best. It can be said that these two concept provide differing means for achieving the same: feedback while driving. The Review concept will thus be dropped from here on. There are some negatives related to the standalone hardware concept, but those will be discussed and addressed in the next chapter, where concept development is discussed.



Adam

age 22
lives in Tilburg
fulltime job

Adam is an outspoken, but friendly guy. His friends appreciate that as he livens up any conversation or gettogether. He does have his downsides though for he can be bad tempered at times. Adam himself just feels that it is mostly because of fatigue.

Adam no longer studies. When he got his diploma a year ago he found a job as technical draughtsman for an engineering company in Werkendam. Living in Tilburg, he has to travel to work everyday at rush hour. Adam thinks he's lucky to have his own car, albeit a simple Caddy van from his employer. Maybe he can move on to something better in the future. To him a car is part of who he is, but he doesn't take it too far. For now he's fine with having a reliable and cheap to drive car. For Adam his car is important. Not just because he has to drive around 25.000 km per year and thus spends considerable time in it, but also because he simply likes to drive. He enjoys driving and controlling a car, while taking in the scenery.

While he was still a student he owned an old car that he used to cruise around with his friends. Sometimes they would just start to drive and see where they end up. Although they may have driven too fast, took some risks, they never had a serious accident. Adam likes to think it has made him a better driver.

Nowadays Adam mostly drives in crowded traffic and he misses some of the freedom driving gave him in the past. He thinks this is more exhausting because of all the things to attend to, especially after a long day of work. He just wished things would speed up. Actually he considers moving closer to his work as the traffic can make him feel itchy. Adam rather drives slightly above the speed limit, giving him a feeling of satisfaction and competence. He doesn't do so in heavy traffic, but when he's closer to home the roads open up and he enjoys that feeling of coming on your own.

His girlfriend Christina is less enthusiastic and she'd rather see him be a bit more careful. But comments are waved away by Adam as he thinks nothing of minor speeding and keeping tempo. It brings no real harm and it makes him feel good. Besides, his friends never complain and even feel positive about his driving style. Adam doesn't think he's a perfect driver; every now and then he gets into a situation that makes him aware of this fact. Adam doesn't like those moments where he apparantly misjudged or relied too much on positive expectations.

Eva

age 19
lives with mom in Etten-Leur
2nd year student HBO

Eva is a usually calm and open girl, who likes to be around other people. She's often surrounded by other people, be it classmates or friends. She likes to visit new places and a car is thus of help to her. Eva sees a car mainly as a means to get to parties with her friends or go shopping in different cities. Once in a while, she uses a car to run errands or take her to school if she's late or if it rains. She knows her mom is fine with that. Eva is happy she now has the possibility to use her mom's car thanks to getting her driving license. Although she doesn't drive everyday day, but if so, she can always borrow her mom's small car. She thinks it's a bummer she has to pay for fuel as she'd rather spend her money differently.

A car itself doesn't really have emotional value to her, maybe if it were her own car. But having a car would be unnecessarily expensive when you can also drive your parents' car that's functionally equivalent. For Eva driving a car is more about getting to the destination and the sense of freedom she gets from being able to drive. The driving itself is less important to her experience, she can't get people who just drive around for fun.

Eva has her driving license for half a year now (after two tries) and she thinks that, having driven about 2000 km, she's doing well. Crowdy moments can be difficult, because she worries that she might miss something important. As she likes to keep everyone and everything upright Eva drives calmly, at the least not faster than the rest of traffic around her. She doesn't want to be seen as 'a little slow' by her friends, since most of them have a license longer than her. Eva thinks she does best by going with the flow of traffic. The somewhat insecure feeling she has when driving every now and then will probably go over as she gains more experience, Eva assumes. She has no worries about the risks of driving, though she knows she's not without faults when it comes to driving. But Eva appreciates it when a friend helps her from time to time by indicating what she can do best at busy crossings.

Her friends think Eva is a fine driver. She's not taking risks deliberately, but sometimes she shows her inexperience by doing things slower than it ought to take. They don't want to criticise her so they keep most comments to themselves. After all, not so long ago they were beginners too and Eva is the kind of person who may ponder too long on any insignificant comments.

Fig. 14 - Two personas of typical users for this concept. Personas are fictional but representative of the target group.

Development 4

The previous chapter discussed concept generation, literature and user research findings. It ended with reasoning to pursue the persuasive robot that gives feedback on driving style.

This part of the report looks at the design development. It has been divided by topic and gives a good view of the reasoning, criteria, solutions and decisions made per aspect of the concept development. Everything is split into categories in this section, but is part of the same concept development, so there may be overlap as things are connected.

§ 4.1 - For whom it is meant

The previous chapters talked about the target group at large, with demographics and reasoning for aiming at this group. This section aims to specify the focus a bit further. The main point to stress here is that the development focuses on young drivers that do take interest in maintaining their own safety. It may look like the largest effect can be had with reckless drivers since there's much to improve, but they are very likely not open to such solutions. This implies that it would have to be forced upon them and if so, any persuasive effects are forlorn since there's no personal motivation from the driver. In short it aims at young drivers who do try to drive safely but occasionally make mistakes and thus could benefit from a system that helps them to identify such situations.

To help illustrate this focus two persona's were drawn up, as can be seen in figure 14. Personas are fictional but representative of the target group, being based on responses from a.o. a user survey (appendix B). The main points relevant to the design process are shown in red. These personas are meant to help create a good idea of the user group by giving this large demographic a face and accompanying story.

§ 4.2 - Timing of communication

The general idea behind the concept is to improve the risk perception of young drivers through direct feedback on driving behaviour. From the user survey (more on this can be found in appendix B) it followed that young drivers would appreciate such a thing if it helps them to improve judgment with immediate effect. This has led to the following criteria, which are explained below to show how these were decided on.

C.1 The communication should be relevant to driving and risk perception.

C.2 The communication choices have to be based on expected safety effect and user desirability.

C.3 The agent gives feedback on driving behaviour, good and bad.

C.4 The agent indicates upcoming situations with a higher than usual risk.

C.5 The feedback is given within the timeframe available for drivers to integrate this information into their judgment.

C.6 The agent does not give feedback on things that happened earlier.

C.7 The agent communicates clearly through a minimal set of easily distinguished messages (see also § 4.3 for a more detailed assessment).

C.8 Agent behaviour should be based on data input that is available (see also § 4.3).

The criteria C.1 and C.7 are similar. Both are derived from the vision that less ambiguity leads to more effect. It's generally considered a smart approach to do one thing well. This concept is about risk and driving, nothing else. It is also about direct feedback as to stir immediate awareness and effect. From that reasoning comes also point C.6 and C.7 to reduce confusion.

Related to that is when the agent could communicate in relation to the traffic situation. Criteria C.1, C.5, C.6 and C.7 are also relevant to the other aspect of timing. The illustration (fig. 16) shows a timeline. Map data is built up from nodes (fig. 15), basically the dots that when connected form a line (thus a road). When lines meet at a node it indicates a crossing of roads. This timeline indicates when the agent could communicate to the driver. It is possible both (well) before, during and after a situation.

Taking into account the aforementioned criteria an optimal solution can be found for the timing of feedback. Figure 17 illustrates the possibilities. It could react directly (a) on things happening and feedback as such. But it could also be based on a moving average or even a trip average, so the driver gets feedback on how their behaviour is on average. This has one major disadvantage: at critical moments the feedback doesn't really take that into account, because it's just displaying an average. Proposal (d) provides a mix of direct onset and then gradually returning to the neutral position. This has one advantage: for a period after a situation the feedback is still available, if the driver were occupied and had missed the message (after all driving itself is their main task).

Integrating the criteria found the direct feedback solution (a) from figure 17 fits best. Thus the agent will respond directly to any situation and after this situation is over, it directly goes back to normal. This gives the design the best possible response to any situation, especially if multiple things occur within a short timeframe.

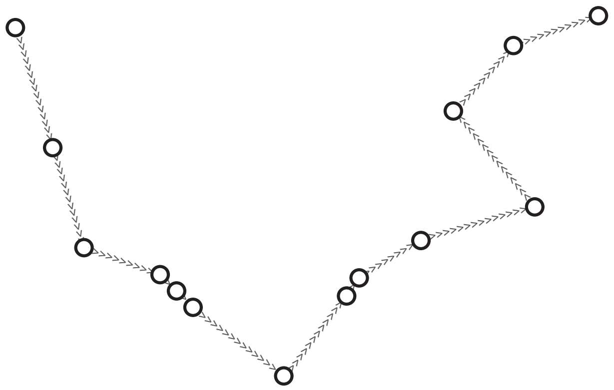


Fig. 15 - Travelling from A to B is as passing from node to node, each representing a roadsection.

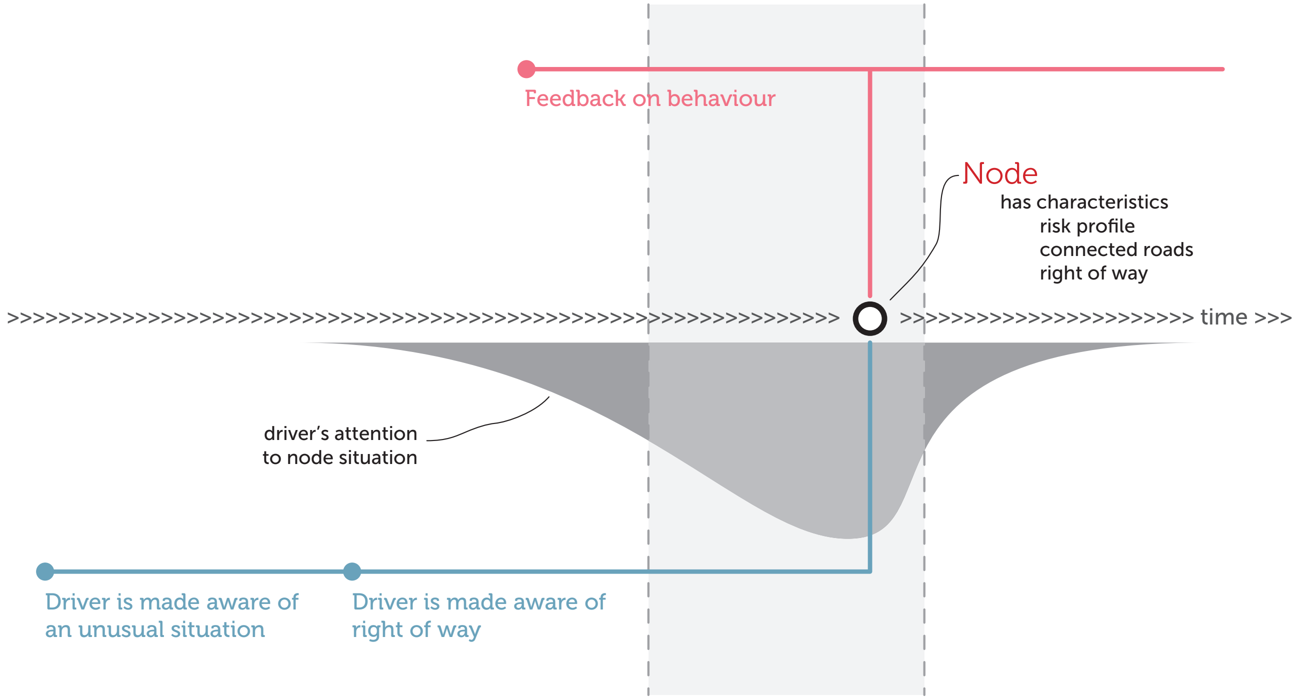


Fig. 16 - Timeline depicting approach to one node, including possible timeframes for certain actions.

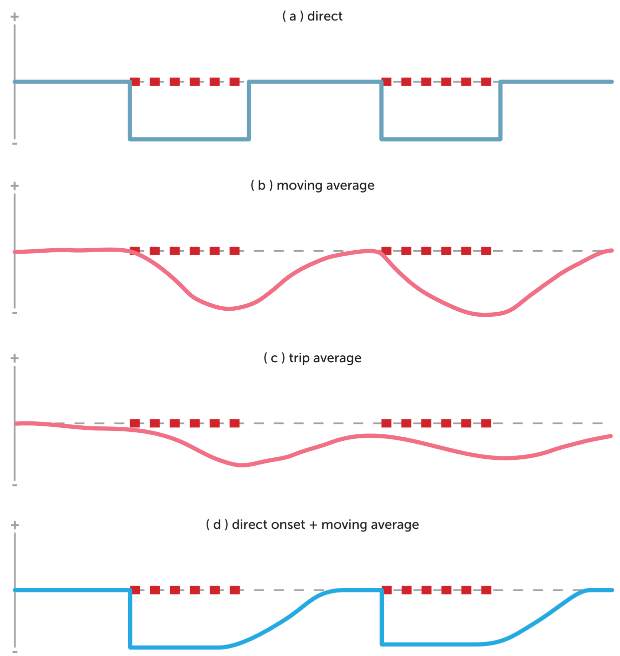


Fig. 17 - Response types for events (marked red).

§ 4.3 - Input & output

This section deals with the data that goes into the concept, where this data comes from and why this particular source is used to generate the intended output. One of the core ideas of this concept is that it thrives on the data a TomTom product holds, such as current speed and knowledge of the road ahead. Doing so it can elevate itself above any competition that cannot do so. The main advantage is knowledge ahead (knowing what's next), plus better tailored feedback.

For this project the focus has been on TomTom PND systems (the separate cases) and not in-dash solutions for input of data. Reasoning behind this is the much larger market share of PND's especially for young, non-car owning drivers. Actual numbers are lacking, but according to TomTom over 12 million PND's were to be sold in 2009 while in-dash equipped cars (Renault Clio, some Fiats) together do not even come close to 1 million sales based on each manufacturer's information. This implies that information from the car itself cannot be used, such as throttle stand and steering data.

	Possibilities to give information on	Info TT	Info Road	Info Elsewhere	Effect	Desirability *
	best route to be taken				+ +	x x x x x
	maximum speed				+	x x x x
	safe speed				+	x x x
X	right of way				+ +	x x x
X	change in right of way				+ +	(x x x x) **
	proximity of pedestrian crossing				-	
	proximity of cycle path				-	
	proximity of traffic lights				-	
	nearing a roundabout				+	
X	nearing road work (change in situation)				+	(x x x x)
X	unsafe crossing				+ +	(x x x x)
X	unclear right of way				+ +	(x x x)
X	high risk spot				+ +	x x x x
	upcoming sudden descent				-	
	traffic jam / congestion				+ +	x x x x x
	bad road quality				- -	
	risks due to weather (black ice / heavy rain)				+	
	unclear roads that cross route				+	(x x x)

Tables 1 (above) & 2 (below) - List of potential warning output (above) and potential feedback (below), with possible sources indicated. A dark green fill means this data is already available, light green implies it is easily added, yellow implies work is needed to include it and red means it's not possible. Blank implies unknown status.

	Possibilities to give feedback on	Detectable TT	Detectable Accel	Detectable Cam	Effect	Desirability *
X	risk taking				+ +	x x
	speeding				+	x x x x
X	driving at inappropriate speed				+ +	x x x
	quick accelerations				-	
	sudden hard braking				+	
	sudden steering				+	
X	too fast cornering				+ +	x x x
X	keeping insufficient distance				+ +	x x x
	sudden change of lane				-	
	driving in opposite direction				-	(x x)
	ignoring traffic lights				-	
X	failing to give way				+ +	(x x x)
	cutting off other drivers				+	
X	failing to notice other traffic				+ +	(x x x)
	wrong place on the road				+	
	inconsiderate of environmental risks (i.e. weather)				+	(x x)
	not looking properly				+ +	(x x)

Tables 1 and 2 indicate possibilities for information ahead (warnings) and feedback on driving behaviour. Colours indicate feasibility of the particular information to be detected. For example, it would be helpful to know if the driver actually gives way to other traffic, but data on the presence, exact position and movement of other cars is simply not reliably available. Selection is based on feasibility, user desirability (derived from user survey) and potential safety effects. If information was missing these values were estimated from similar items.

The selected items (marked with an X in the leftmost column) were grouped according to the categories shown in table 3. Items that are unfeasible were removed and so were duplicates. Table 3 shows the final set of messages that the agent should be able to communicate. There are three types: positive reinforcement (keep up this behaviour), negative behaviour (condemn behaviour) and positive persuasion. This last type is meant to communicate warnings ahead to persuade drivers to integrate this information into their judgment.

Initially there was a fourth category: indication of right of way. The agent would indicate if the driver approaches a crossing where she has to give way if other traffic is around. It would help to forego any unclear situation. Usually this information is out in the world (traffic signs) and thus it may be redundant, but helpful in unclear cases. However, because truly difficult or unclear crossings would be marked by the 'upcoming risky situation' category as well, it's also redundant with other actions 'within' this concept. Therefore, it has been decided to leave it out to reduce complexity and hereby improving clarity for the end-user. It is helpful information though, so I feel it's an opportunity for TomTom to integrate this information with the usual display of road layout on their products.

Possible messages	Positive reinforcement	Positive persuasion	Negative feedback
appropriateness of driving in context	your driving is considerate		you're (probably) not taking enough care considering the situation
upcoming risky situation		be careful, situation ahead needs attention	

Table 3 - Final set of message types that will be used further on.

§ 4.4 - Data & processing

In the paragraphs above the to be communicated messages are lined out. The tables 1 & 2 indicate how certain data can be acquired and whether it is feasible. In this section each message category is discussed in terms of data acquisition and how it leads to output. Figure 18 gives an overall schematic representation.

Upcoming risky situation

(map info: high risk spots + live data on road conditions) + (accident data) + (position / direction)

This category has just one kind of output: to persuade the driver to be careful, as the upcoming spot is deemed risky. It needs to know which places it is approaching, based on GPS data. Secondly, these spots need to have a risk factor attached. This risk information can be based on historical data, such as rate of accidents, clarity of crossings and live data, i.e. for road blocks and sudden traffic jams. These items need be integrated into the map data or else be available via Live services. Then the system can determine a risk factor and if this factor exceeds a threshold the agent communicates this to the driver.

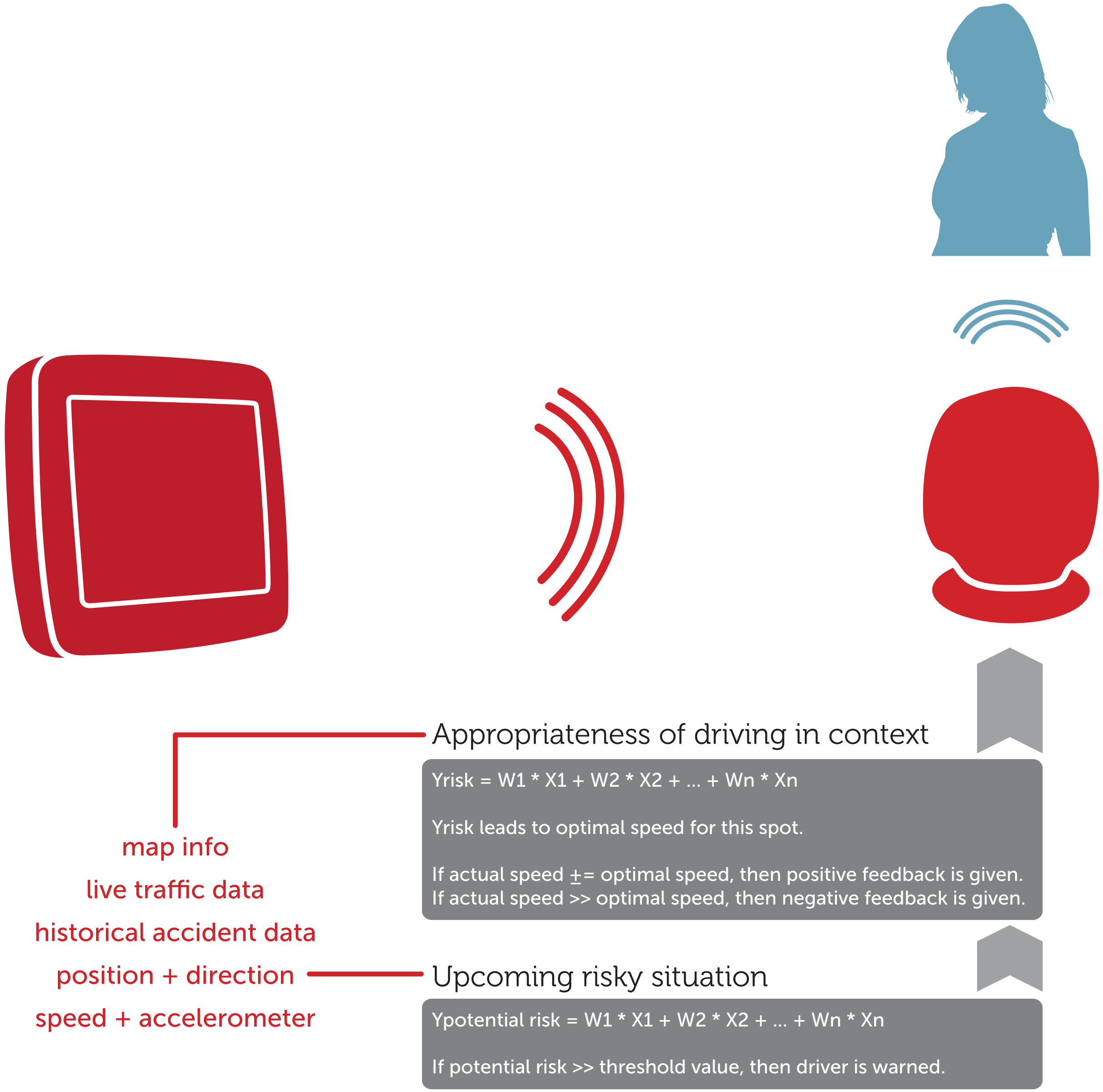


Fig. 18 - Schematic representation of the system's model. Data from PND is fed to object, which in turn interacts with the driver (the latter not shown here).

Appropriateness of driving in context

(map info: risk analysis based on map info) + (position / direction) + (actual position & speed) + (accelerometer)

This category intends to give feedback on how well a driver adapts to a situation, usually a crossing or point where a driving decision needs be made. Also, it can be used to judge speeding on 'straight' sections. Just as with the previous category the system needs to know which spot it is approaching, based on the current direction and map info. Again, a risk profile is established to come to an advised speed for the driver to handle this situation (be it a crossing or straight road). This advised speed is then compared to the actual speed (GPS data) to form a verdict. When the actual speed is too high the agent will show negative behaviour to illustrate risks taken. When fine, positive behaviour should be shown (but due to some caveats it will be discussed later in more detail).

Risk profiling is based on statistical prediction and not on actual, true traffic information. That would be impossible, at least in the foreseeable future (i.e. due to unknown presence and behaviour of other traffic). Because this category of messages is deemed very important to the overall goal of improving young drivers' safety, it was chosen to include it and focus on choice of speed when handling a traffic situation, even though results cannot be perfect. As indicated before (see fig. 7 - relative incidence of causes) this is one of the main causes of accidents. Other very important factors such as appropriately dealing with other traffic and place on the road cannot be dealt with. In short, with regards to feasibility this seems the best approach.

Yrisk = W1 * Xright-of-way + W2 * Xequal-crossing + ...

The above formula gives an idea of the risk estimation. It combines knowledge of the spots' attributes (predictors) with given weights (determined by i.e. linear regression analysis) to get a risk prediction. This prediction is then used to determine an advised speed, like explained in the previous paragraphs. Possible predictors are: equality of a crossing, right of way, clarity, historical accident data, roundabout, traffic lights, stop signs, amount of traffic (historical or live data), recent change in situation, maximum speed, speed differences, corner, and the route to follow.

Because the risk profiling is based on statistical information (basically averages) it cannot result in a perfect verdict. On average it should be correct, but it can be off. How effective is this then? It is known that trust and thus persuasiveness of a system is linked to accuracy (a.o. Sharp, Rogers, Preece, 2007). It leads to the following conclusions:

(1) The system cannot be guaranteed to give perfectly appropriate feedback, but (2) on average it should be reasonably close. (3) The agent should only give negative feedback if the actual speed is significantly higher then the predicted optimum, to reduce the potential error in judgment. (4) In similar fashion, positive feedback should be restrained as well to avoid situations where the driver seems to drive appropriately based on the prediction, but actually had to stop to avoid problems. This is something the system cannot account for and thus giving a wrong message should be avoided to forego losing trust.

During the design process it brought up discussion on whether it wouldn't be better to to have the agent communicate a trip average (see fig. XX and accompanying text of § 4.2). It could be better suited to its data acquisition, but is at odds with the criteria lined out earlier, most notably that immediacy of feedback will have the best effect. Occasional slips must then be accepted as a tradeoff. Table 4 addresses this issue as well by comparing various concept possibilities to social and technical design criteria. From this can be concluded that the type discussed in this section is the best solution. The concept will thus give immediate feedback and alert the driver ahead of a situation (feedforward).

	Product types				
	direct feedback	direct feedback + feedforward	average feedback	average feedback + feedforward	direct + average feedback + feedforward
SOCIAL CRITERIA					
privacy	1	1	-1	-1	-1
free choice	-1	-1	1	1	-1
betutteling	-1	-1	1	1	-1
self-selection bias	-1	1	-2	1	1
risk experience	1	2	-2	1	2
user's investment	-2	-1	-2	-1	-1
clear effect (counted 2x)	1	2	-2	-1	2
anticipatory effect (2x)	1	2	-2	2	2
DESIGN CRITERIA *					
complexity of product	2	1	2	1	-2
complexity of interaction	2	-1	2	-1	-2
manufacturing costs	2	1	2	1	-1
TOTALS	7	10	-7	5	2

Table 4 - Comparison of feedback and feedforward (warning ahead) types. Criteria in yellow count double due to importance stemming from project goals.

§ 4.5 - Expression of content

The earlier sections define what the agent is supposed to communicate and on what data the feedback is based. This part discusses how the intended content can be expressed to the end-user. This section thus builds upon the previous sections and the criteria mentioned there (noted with a C.# for easy reference).

It is complemented with a few other criteria. These criteria are based on the key characteristics of the concept, namely a figure that tries to make the driver aware of risks. This trying is inherently persuasive (H.1, see list below). Because people show stronger influence from a social agent than from a non-social agent (a.o. Midden & Ham, 2009, see also § 4.9), the agent should aspire to be social. Social means here that it communicates in similar fashion as people would do. Criterium H.4 complements this notion as well as stressing clear communication. H.5 (agent is an aid) stems from the vision that people are very wary of someone or something that tells them how to do things (survey response shows this). Lastly, because the agent is meant as a physical thing it should use the inherent possibilities there. Thus the extra list of criteria looks as follows:

H.1 The agent communicates to persuade.
H.2 The agent should be seen as a social entity.
H.3 The agent is a physical object and will exploit its possibilities.
H.4 The agent communicates without ambiguity or symbolic meaning.
H.5 The agent is an aid, not a critic nor distractor to the driver.

Let's look at the possibilities: how can something communicate with the outside world? Through sounds, voice, light, making movements, facial expressions, changing size or by touching are the prime candidates. Based on the criteria a few seem better options: light, movement, expressions (essentially movements) and changing size. Sounds are seen as ignoring H.3 (exploiting physicality) and touch is impractical during driving. The use of light, for example through different colours and intensities, fits the criteria except for the fact that it is this concept's characteristic not to use light as its main means of communication. Given this reasoning and the fact that the agent should have social qualities, movement and especially gestures are preferred over the other possibilities. Because H.4 states that the agent shouldn't be ambiguous or symbolic, it is felt that communicating emotions through simple movements provide the best fit for the concept.

To establish which emotive behaviours it has to show, a stimulus-response model has been used. Specifically, Plutchik's theory of emotion (1980) has been used. While this classification may be old and other models have been proposed, it fits here for the following reasons: it's (visual) representation (see figure 19 on next page) is well suited for picking a small set of emotions that need be distinguishable, it is not superfluously detailed and the classification can be used in the stimulus-response model such as shown in table 5 (next page). This model helps to determine the link between intended effect (known), stimulus (what's happening, also known) and how the agent can respond appropriately. The 'thought' and "intended action tendencies" (Fredrickson, 1998. Via Smith et al, 2003) determine the best set of emotions to show.

In line with the criteria, the intended actions of the concept are targeted towards improvement and especially not angering or inducing fear, because both these reactions diminish risk calibration (Lerner & Keltner, 2001; Johnson & Tversky, 1983. Via Smith et al, 2003). Rather, it should aim at retaining positive driver behaviour, while reducing negative behaviour. This mode of operation is usually referred to as shaping behaviour. The section that follows aims at filling in the question marks of table 5.

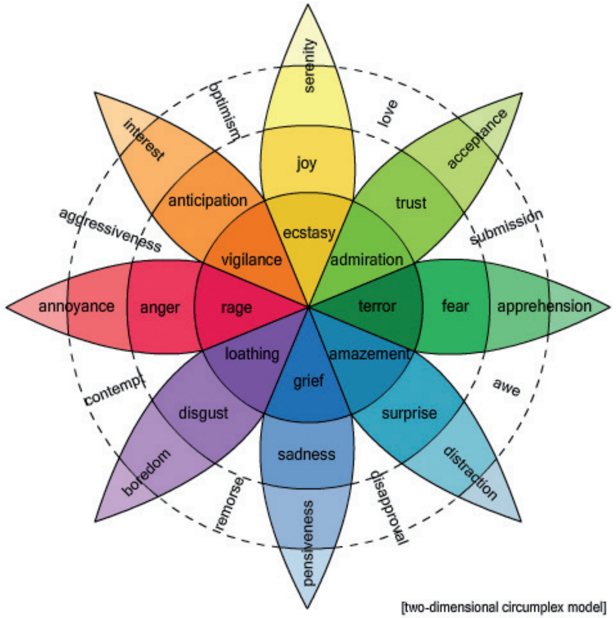


Figure 19 - Plutchik's wheel of emotions (1980). Image courtesy of WikiPedia.

§ 4.6 - Emotive behaviour

Based on the results of the previous section this part looks at how the persuasive agent is actually going to show the driver its feedback. At this point it has been decided that the robot will use expressions that depict an emotive evaluation of the current situation. Three types were chosen, see also table 5 on previous page.

I could have designed the gestures myself after which I would need to check to see if the design corresponds with the target group's views of what it depicts. Instead, inspired by the process shown in the Emotionally}Vague project by graphic designer Orlagh O'Brien (2007), I turned the process around. It lets the user group design gestures by presenting them with a wiredoll which they could bend and move to their liking. After explaining that the doll is to be placed on the dashboard of a car and gives feedback on the

Stimulus event			Cognition	Emotion	Behaviour	Effect on persuadee
appropriateness of driving in context	3	positive	"possession of safety"	optimism / graditude	?	retain behaviour
	1	threat / loss of safety	"danger"	fear, sadness	?	regain safety / drive slower
upcoming risky situation	2	upcoming threat	"danger" / "examination"	anticipation / nervousness	?	alertness

Table 5 - Stimulus-response model for persuader and persuadeed based on Plutchik (1980).

driver, participants were asked to provide a positive gesture, a negative one and an alerting gesture. The order of the three tasks was randomised. Figure 21 shows a collage of the results. One column represents the results for one participant. Figure 20 summarises the results into unique gestures.

The gestures displayed in fig. 20 are arranged to show conflicting ones together in one column (not all are conflicting of course). For example, from the positive gestures (p1) was by far the favourite. This conflicts with (n1) and (a1) as all have hands up high. A suitable combination can be made with (n2) or (n4) and (a2). Gesture (a3) could be conflicting with (p1) as both feature hands upwards. Because n2 and n4 can be combined into one gesture with arms and head down, that looks like the best deviation from (p1) and (a2).

It should be noted that the alerting gesture includes up- and downward movement of the arms in order to raise attention. This feature also distinguishes it from the two evaluative gestures. So recapping, the final design to be discussed in chapter 5 will use gestures based on (p1), (n2) + (n4) and (a2) from figure 20.

Positive stance

open, extrovert, exuberant

Negative / disagreeing stance

introvert, scared, cocooning, despondent, no anger

Alerting stance

open, active, attentive, aiming at driver

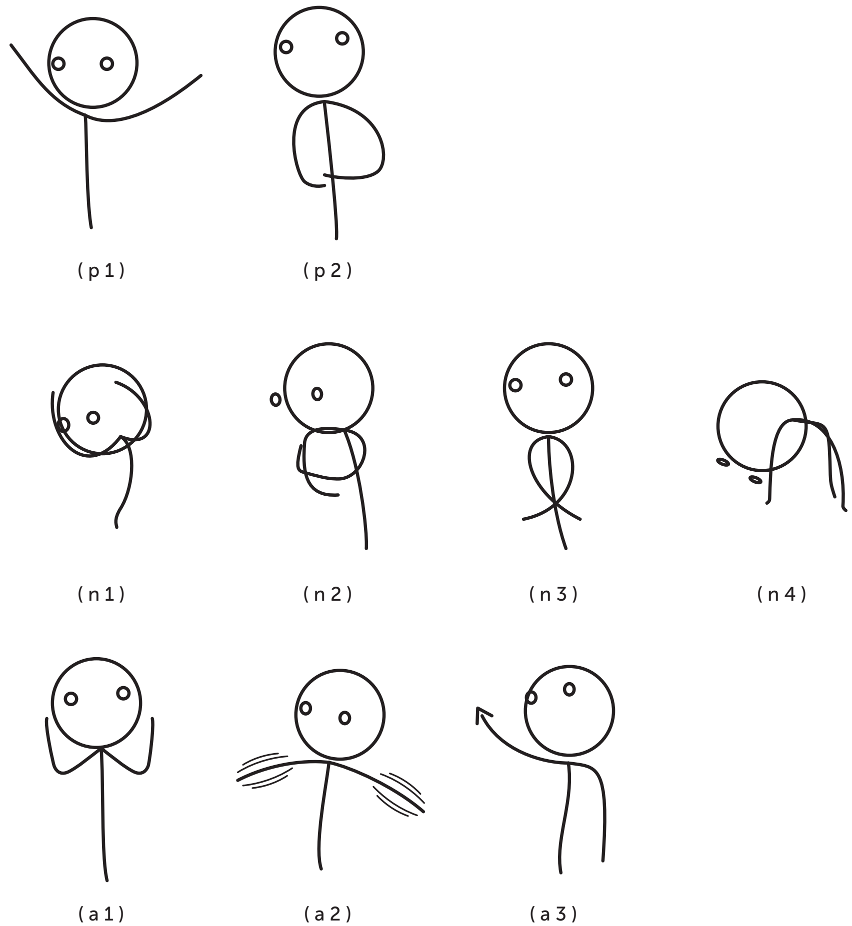


Figure 20 - Collection of the different gestures made by respondents using a wireframe figure.

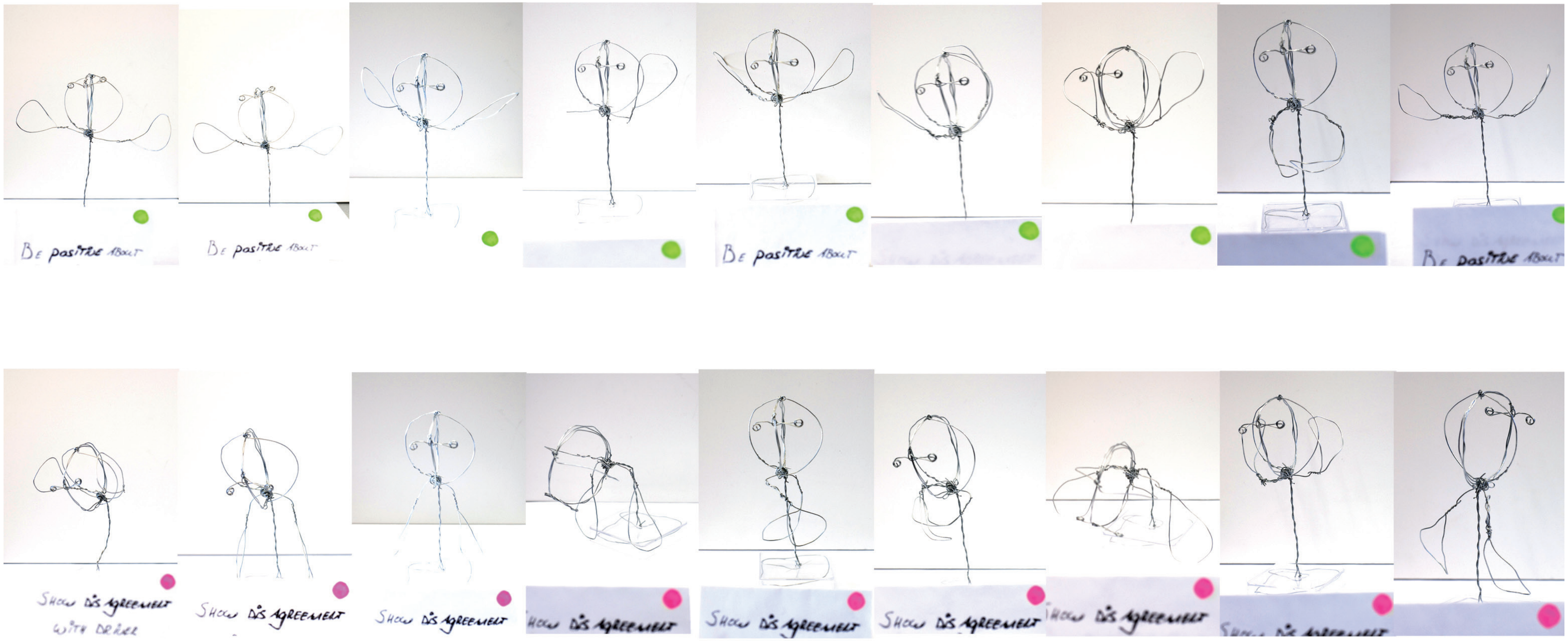
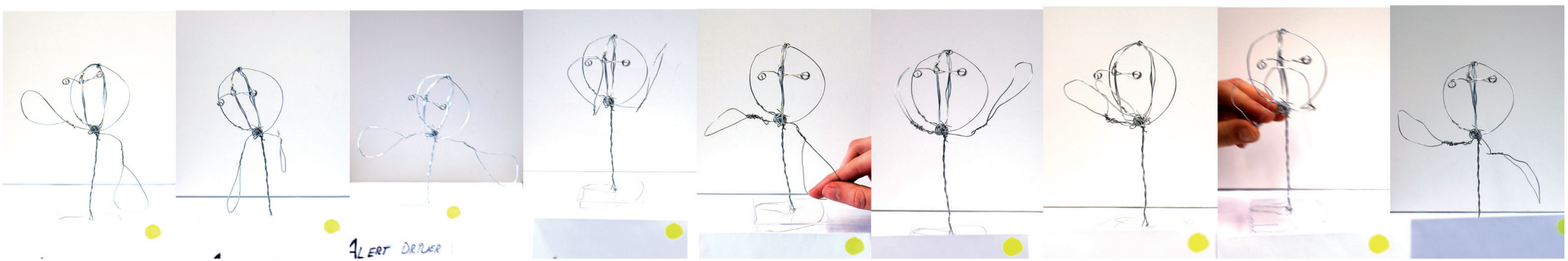


Figure 21 - Collection of the different gestures made by respondents using a wireframe figure. Each row represents one respondent. Top row are positive, middle negative and bottom row alerting gestures.



§ 4.7 - Placement

On a more basic level compared to the complexities of previous sections is the placement of the design within the car environment. One of the main characteristics of the persuasive agent is its physical appearance, so it is a hard requirement that the actual design is a physical object separate from the TomTom PND or in-dash system. It does require the TomTom navigation device for control, but this data connection is not necessarily physical (P.2). In fact, the client has indicated that TomTom has a strict policy to only connect to other devices via either USB-cable or Bluetooth wireless technology. Because the concept is likely to use small motors that draw a substantial amount of energy and TomTom's PND devices can be battery-operated, it is a smart decision not to let the concept depend on a PND for its energy needs. From this technical issue follows that the concept is very likely in need of its own power source for example via the cigaret lighter charger, similar to what the PND's also use. Therefore it's necessary that the two items share this power source (most cars have only one such connector). Reasoning from there on leads to a few options: (a) separate cables that run to each object (PND and agent), (b) one cable that runs to one device and another cable or extension that goes the second device, (c) the two devices are connected and fed by one cable.

See figure 22 for a representation of these solutions. It stands to reason that option (a) is not practical. Because cleanliness is important for pleasant use and a good view, solution (c) is preferred over the other two. Thus the agent should be physically close to the PND device so they can share one power source without ugly cables to connect. A nice side effect is that when looking at the TomTom screen the driver can easily glance at the agent as well. This implies the agent should be in view but not be obstructive. The best solution is then of course on top of the dashboard, as was the original idea. Other positions such as integrating into the dashboard itself, hanging it at the rearview mirror are considered less effective or obstructing.

(continuing on next page)

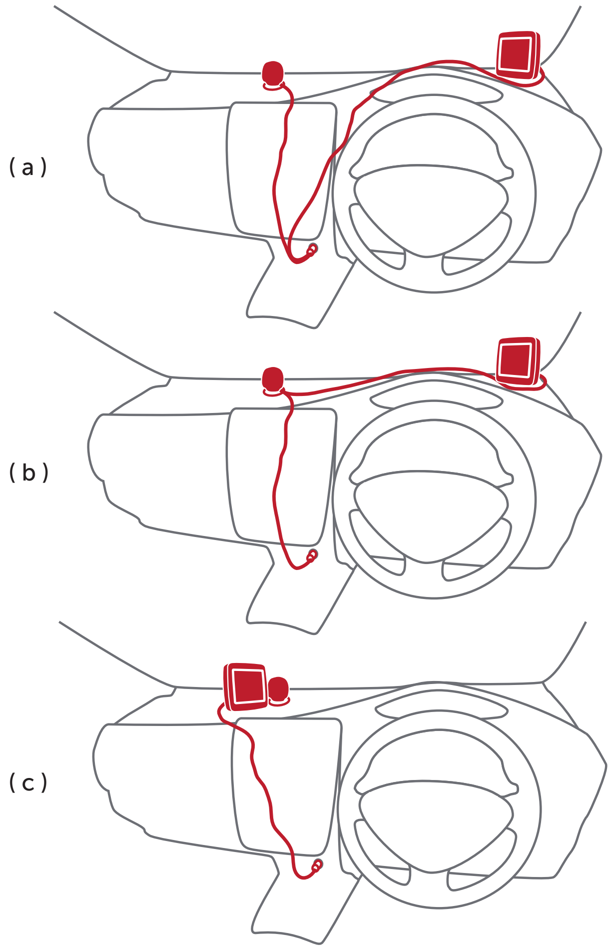


Figure 22 - In-car placement possibilities.

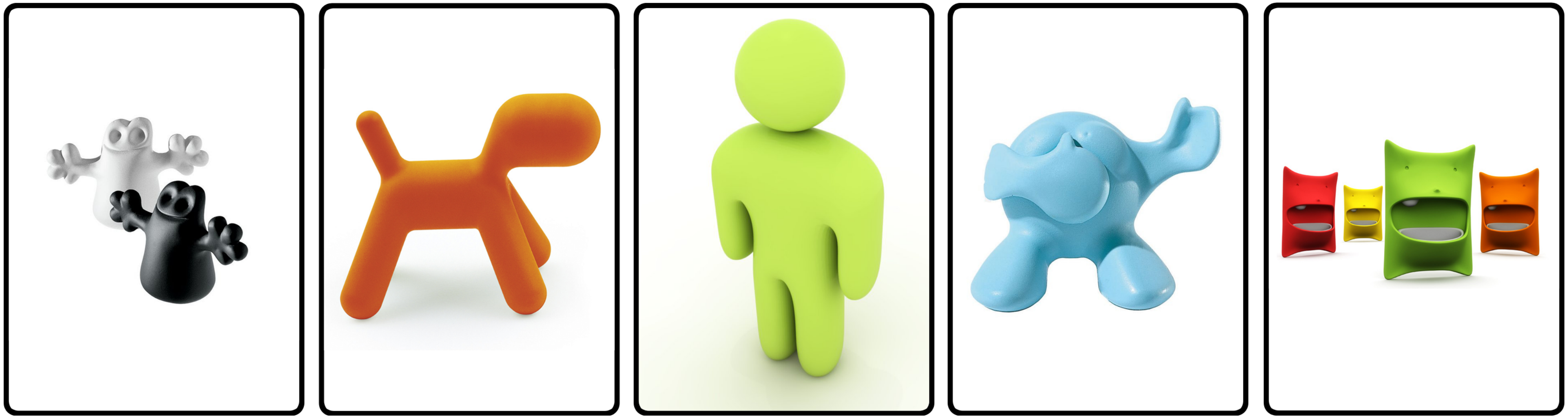


Figure 23 - Cards with figures shown in order of preference by participants from left to right, with best liked one the left. Continues on next page.

This then, leads to the following criteria for physical placement of the product: (1) The agent is a physical item, not part of the TomTom PND or such devices. (2) The agent is connected to the TomTom for data and preferably attached to it physically. (3) The agent is clearly visible to the driver. (4) The agent does not obstruct the view (does not degrade the driver's performance).

Thus solution (c) in figure 22 is the best fit with the criteria mentioned here. The design will be placed in proximity of the TomTom PND.

§ 4.8 - Form development

In this part the process is discussed for the development of the visual appearance. Of course is it strongly related to the previous section on placement of the product. It was decided there that the concept is hooked up to a TomTom PND. Of course, in case a built-in system is used instead of a PND the power cable runs directly to the agent object. It should thus be designed to facilitate both possibilities. Most important though is that the whole design is meant to be persuasive and from this follows that is best done when the design has social qualities (see also § 4.5 and § 4.9). To reach this goal a connection between user and agent is needed, hence the agent needs affective qualities to support the persuasion. This affective quality should thus be a very important criterium for the design process.

In order to get a better understanding of target group preferences for the visual design, a short investigation was carried out. Ten photos of figures differing greatly in appearance were put on cards. These cards (see fig. XX) were then shown to people, who could rearrange these cards in order of their liking. The





resulting positions were noted. Figure 23 shows the best liked figure on the left and in order of liking towards the right. From these results a couple of things can be concluded. People favour more abstract figures over very extravert ones. There seems to be a slight preference for animal-like creatures compared to anthropomorphic figures, but the high-ranking green human undermines this conclusion. This non-expressive figure also goes against the comments of most respondents to favour expressive figures such as the little ghosts. It should also be noted that limbless figures tend to score lower, with the highest one ranking fifth. Also men ranked the porcelain girl (7th) lower then women did, so perhaps genderless figures are a better choice unless multiple designs would be brought to market.

It has been decided not to pursue the form development process to free time to detail other aspects of the design. This is in line with my development plan for this semester which doesn’t focus on form & senses. So the information gathered should be seen as steps towards a design brief for out-sourcing the form development.

Figure 24 - Foam models were made as means of a first study, before the cards on the previous pages.

§ 4.9 - Anticipated effect

The previous sections have discussed what the concept is, how it intends to operate and for whom it does so. The next section will look at the added value which cannot be judged separate from the anticipated effect of this system. So the basic question here is to what extent does this system help to improve safe driving for the target group? A direct answer is not available, but two research projects discussed here provide a strong case for positive effects.

The first project (Musicant, 2009) involves a study of a reckless driving warning system very similar to my speeding awareness concept. During this study 50 students were followed on some 18.000 trips by using small onboard camera's and accelerometers. Halfway the study a warning system was enabled that had green, yellow and red LED-lights mounted on the dashboard. Enabling the system led to a reduction unsafe driving behaviour of over 50% (an earlier study states averages around 32%). The longevity of this effect is discussed in an earlier article (Musicant, Lotan, Toledo, 2007) and from the data it appears that up to six months after the exposure to feedback the effect remains, after which it gradually climbs back to original levels. In short, this study proves that a driving style feedback system can have significant effects towards reducing unsafe driving.

The second study (Midden, Ham, 2009) (Vossen, Ham, Midden, 2009) has been mentioned before. In this study the effect of sociable feedback via an embodied agent (a robot) is compared to feedback from a computer. The task at hand was setting a washing machine to a good setup, where good is a participant's personal judgment. The feedback aimed to persuade the participant to pick an economical washing program. It was found that the strongest persuasive effect was found with the most social feedback, although apparently only negative feedback seemed to cause strong (intended) effects. Further more the study indicates that evaluative feedback (expression an opinion) has a slight effect favouring it compared to factual feedback (stating actual economy). These results speak in favour of the decision to go with a sociable agent for my design.

Taken together these studies indicate that positive effects resulting from the use of this design concept are likely. Of course it must be noted that some of these findings may or may not transfer to this concept. Without extensive evaluation however, this provides the best indication.

§ 4.10 - Value proposition

Now most development issues are discussed it is finally time to discuss the value proposition of this concept. What value does it bring to consumers? And what value does it bring to TomTom, being the client? This part aims to clarify those things, though a real answer can only be found in the market. This project is more conceptual in nature, in the sense that it hints at an opportunity for the target market.

First up is a look at the use incentives for this concept. Based on user feedback, explained in more detail in § 3.12 and appendix B, it was decided to focus on the immediate situation and warn ahead of tricky situation. The goal is that feedback can be integrated into the actual driving rather than reflection in hindsight. Especially warning for dangerous situations scored quite well in the user survey (fig. 13), but for example feedback on safe speed less so. Thus it can be said that the advice (ahead) provides an use incentive, while feedback (on actual driving) is a mechanism for persuasion (to do better in the future). For effect you'd need both. More down to earth, young drivers say they're interested if it helps them.

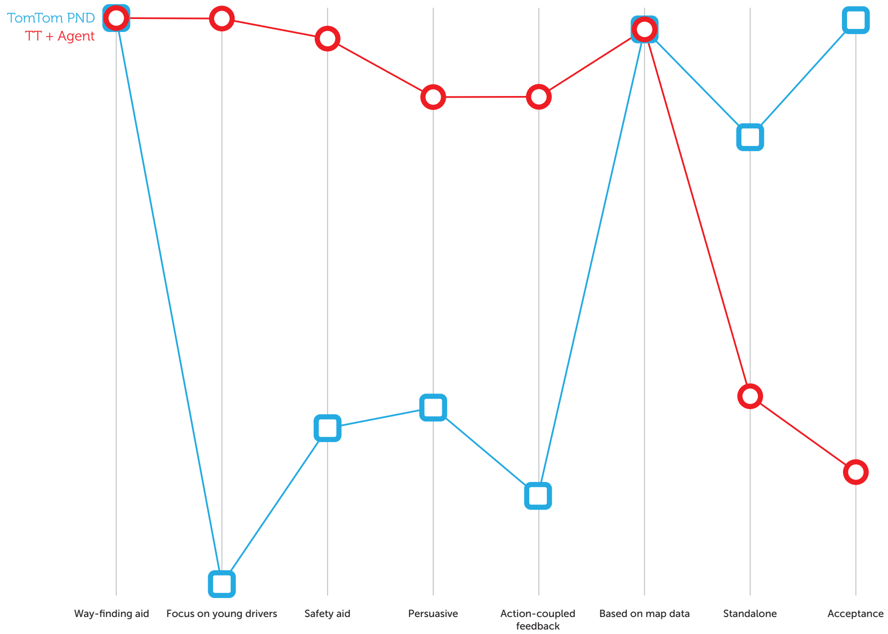


Figure 25 - Strategy canvas that contrasts a TomTom navigation device with a TomTom product + my concept.

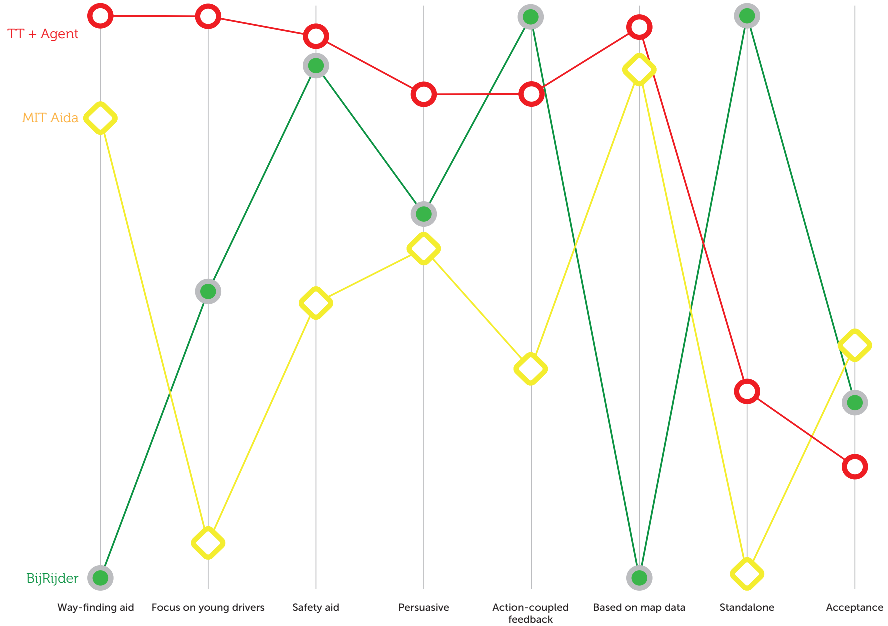


Figure 26 - Strategy canvas comparing my concept with two potential competitors.

Figure 27 - Depictions of BijRijder concept and MIT's AIDA project.

To what extend or price they're willing to acquire such a product is unknown at this point.

In order to have a better look at the value proposition a strategy canvas has been used. This ranks competing systems on a number of values important to users (instead of just ranking features). The resulting canvases are shown in figures XX and XX. The first contrasts this project's concept with a normal TomTom PND to illustrate where it makes a difference. The second canvas compares it to two potential competitors, also shown in figure XX. These competitors were chosen because these appear to be close to the overall goals of this project. Both are still concepts though and details on the workings aren't fully available. The first, the BijRijder (de Torbal, 2008), consists of an artificial bee that is mounted in view of the driver and responds to the driving style by making noises and flapping its wings. The second, AIDA (or Affective Intelligent Driving Assistant), is currently developed by MIT (2009) in cooperation with Audi and aims to be a driving companion which has complete knowledge of the car, route, road conditions and even mental state of the driver. Basically it uses all possible data to inform and persuade the driver about the best possible route and warns against dangerous situations and improper driving (and drowsiness, and ...). The main conclusion here is that basing the feedback on map data and aiming specifically at safety delivers the best competitive value.

To clarify the value this product may hold for TomTom, we need to look at the business case of the company. My personal view of TomTom is that of a software company which sells this software either alone (PDA or iPhone) or as part of a package (PND). Once a growth market with few competitors the car navigation market has matured with fiercer competition and decreasing margins. In short: the software is going to be free (see Google's efforts with Maps Navigation), undermining TomTom's business model. This asks for diversification based on TomTom's strengths which is (again in my humble opinion) user experience, mapping technology and brand image. This concept specifically aims at the driver experience largely based on map and live data. It differs in what it is: a truly physical product, not just software, extending beyond what TomTom offers now. Still it is as good a match with TomTom values such as aiding driving, safety and fostering a driving companionship. As mentioned in the first paragraph of this part, this project should thus be seen as exploring an opportunity for TomTom to diversify their portfolio. Based on the findings there is definitely something to it.

Chapter 5 Final design

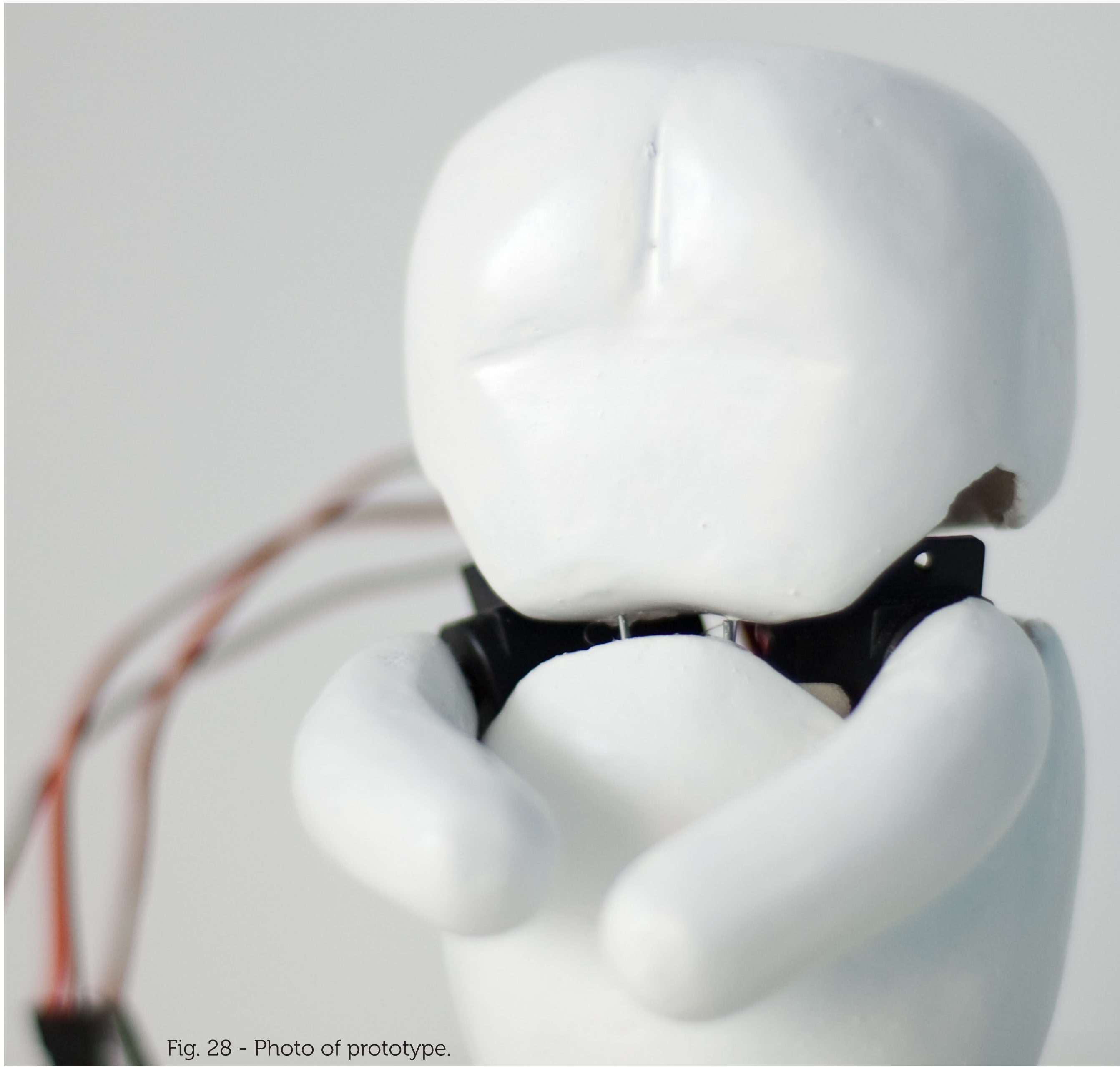


Fig. 28 - Photo of prototype.

In this chapter the final design is discussed and explained. Logically this design is derived from the developments discussed in the previous chapter, but here it's brought together for a complete image of what the concept does, does not do and how it operates. Also some caveats are mentioned.

A prototype has been built which is able to depict the intended gestures. The expression and technicalities of this prototype will also be covered in this chapter.

§ 5.1 - Final behaviour

First, the actual behaviour will be explained in this part. It builds from all that was covered in especially § 4.3, § 4.4 and § 4.5. To recap what was concluded before, the general principles will be repeated. The agent will use emotive gestures to establish itself as a social actor. Doing so the agent's persuasive content will have a larger effect (§ 4.9) compared to non-social feedback. This feedback aims to persuade the driver to adjust the driving style in case this style is deemed inappropriate by the system. This persuasion is split into two categories (table 3 in § 4.3): warning ahead (potential risk) and feedback on appropriateness of driving in the context (evaluative). The latter has two options: positive and negative feedback.

Generating this behaviour is based on predictions the system makes about the current (or upcoming) situation. It has to use predictions because not all valuable information can be gathered. Some of this information cannot be gathered at all (i.e. presence and intentions of other traffic) and some of it not timely. Because of user feedback and potential effects timely feedback is considered necessary. Therefore the system will make predictions based on as much factors as needed, though for the rest of this chapter a subset will be used. This subset and the range of predictors can be found in table 6. Based on these factors a model can predict the risk for a given road section.

Predictors	Values	Measurement	Source	Easily determined	Suitable
is a corner	true / false	objective	map info	X	
is a roundabout	true / false	objective	map info	X	
is a crossing	true / false	objective	map info	X	X
equal crossing	true / false	objective	map info	X	X
right of way	true / false	objective	map info	X	X
clarity of situation	0 - 100	subjective	human observation		
historical accident data	x per year or people that pass by	objective	accident database		
regulated crossing	true / false	objective	map info	X	
traffic lights	true / false	objective	map info	X	
stop signs	true / false	objective	map info	X	
amount of traffic (historical or live data)	x per time unit	objective	traffic registration system		
recent change in situation	0 - 100 (ranking of change)	subjective	map info		
maximum speed	0 - 120 km/h	objective	map info	X	X
advisory speed	0 - 120 km/h	subjective	map info		
current traffic speed	0 - 120 km/h	objective	traffic registration system		
speed differences	0 - 120 km/h	objective	map info	X	
route	straight / left / right / turnaround	objective	planned route		
Additional data sources					
Current speed	0 - 400 km/h	objective	GPS	X	X
Current acceleration / deceleration	± 10 m/s2	objective	GPS / accelerometer	X	
Distance to node	0 - 1000 m	objective	GPS + map info	X	X

Table 6 - List of predictors, with suitable ones for a quick approximation indicated.

To see how it works the road plan of figure 29 shows the predictor's values for a number of crossings. Based on these factors a very simple logic can determine the optimal speed for the driver to pass this section.

This logic is shown in code piece 1, where based on three factors an advised speed is determined. The speeds named in this example are approximate and in accordance with what my driving instructor taught me. The main idea is that for a safe passing of this section the actual speed should be close to the advised speed. If above this speed, then negative feedback is given. The next paragraph will detail this. In similar fashion the predictors from table 6 can be used to predict risk further ahead to issue an alerting gesture

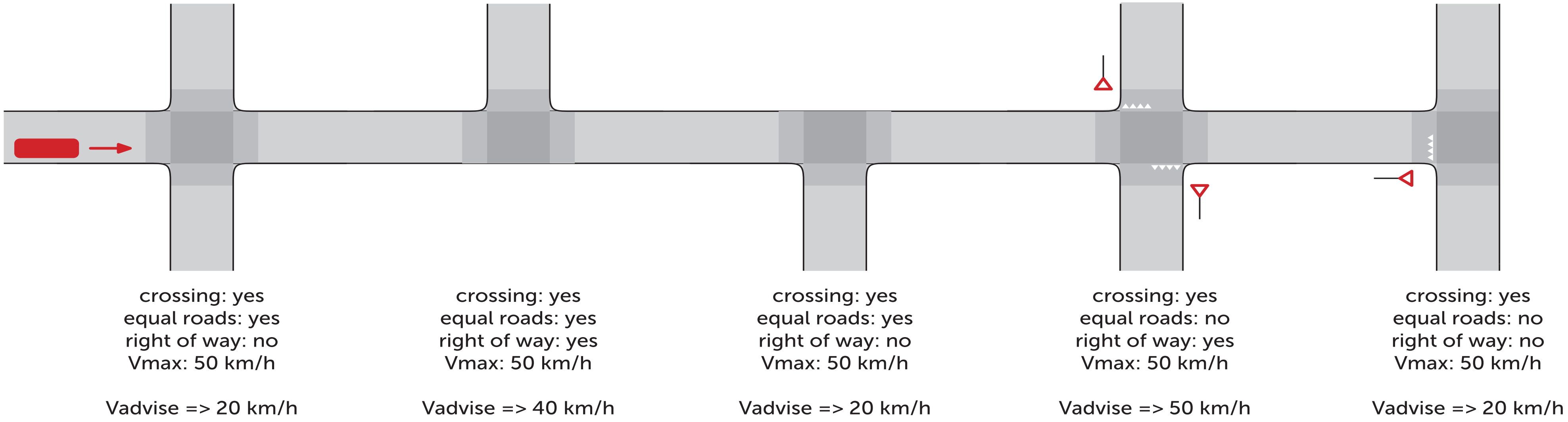


Fig. 29 - Road with crossings, included values for predictors to be used in risk analysis.

towards the driver, so the driver can take it into account when making a decision on how to deal with the situation.

A more in-depth explanation for the approach is needed to cover all details. For this explanation figure 30 forms the basis. It shows a timeline for an average approach to a crossing at 50 km/h. As the previous paragraph outlined the safe approach speed would be 20 km/h. This speed would have to be reached in advance of entering the crossing. During driving lessons it is taught that 'being done and ready' ± 15 meters ahead is considerate. Fifteen meters equal 3 seconds at a speed of 20 km/h. From there on the system can calculate backwards to determine the optimal speed for the approach. Using an average deceleration of 0,9 m/s2. Lower and upper bounds used are 0,4 m/s2 and 1,4 m/s2. These values are based on field studies (Bennett, 1994) done on New Zealand drivers. The values found may differ for European drivers, but it wouldn't change the overall workings of the system.

Figure 30 shows the upper and lower bounds of the

```
if ( is a crossing ) then
    if ( equal roads ) then
            if ( have right of way ) then
                        Vadvise = 25 km/h
            else:       Vadvise = 20 km/h
    if ( no equal roads ) {
            if ( have right of way ) then
                        Vadvise = Vmax
            else:       Vadvise = 20 km/h
if ( not a crossing ) then
    Vadvise = Vmax
```

Code 1 - Example logic to derive advised speed for a given road section.

speed bandwidth, with speeds lower than advised in blue and higher in red. The principle is to calculate the speed bandwidth for the current distance to the crossing. Having this, the actual speed (derived from GPS data) is compared and feedback is given if necessary. Driving faster than the bandwidth advises makes the agent shows negative feedback. The opposite isn't that easy though. Driving slower than advise or even coming to a complete stop doesn't say you're acting safe. Likely the situation forces the driver to stop, for example because another car has right of way. But if so, driving slower than 20 km/h but not completely stopping is still unsafe! Because the system has no perfect view of any situation it leads to the conclusion that it can indicate when a driver shows risky and unsafe behaviour, but it cannot tell when the driver is acting safe. And following from this rationale it must be concluded that positive feedback is hard to give since the basis for it has caveats.

The solution to this issue is to use positive feedback less for immediate response, but rather to give an indication of how well the driver is faring for the past short period of for example five minutes the driver did well according to the system, then it is positive. Else it is neutral in expression. This rationale is a break from the criteria mentioned in the previous chapter and goes against some of the core ideas, but given the limitations of the system this solution appears best. Alternatively positive feedback could be left out, but reasonably that diminishes appeal. Who wants an aid that cannot be positive?

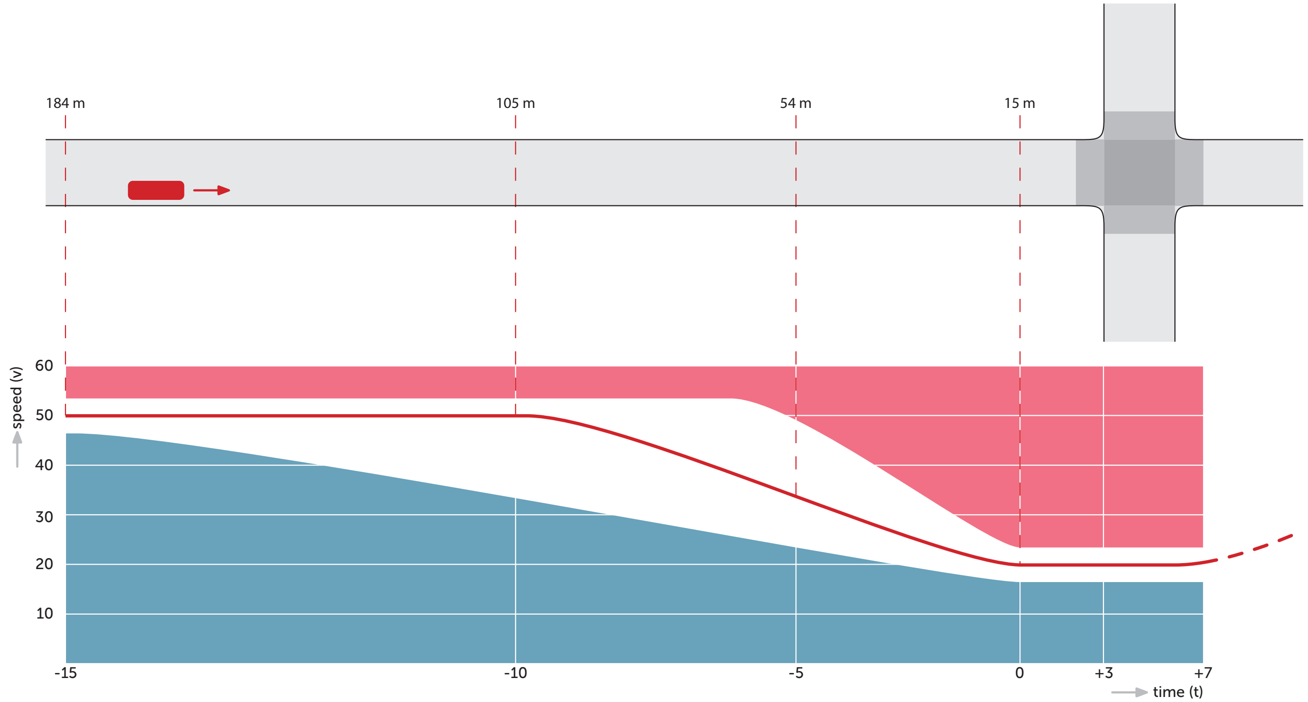


Fig. 30 - Timeline and distances of the approach of a crossing. Red line is average deceleration, in white the safe bandwidth is depicted.

Lastly, the warning ahead for risky situations will be discussed. Alerting should be done before the line slopes downward (fig. 30), thus while not approaching a crossing, including a short interval between alerting and evaluative gestures. This may imply that no alert can be given if for example crossings follow up quickly, otherwise things intermix and potentially confuse the driver, losing trust and persuasive effect.

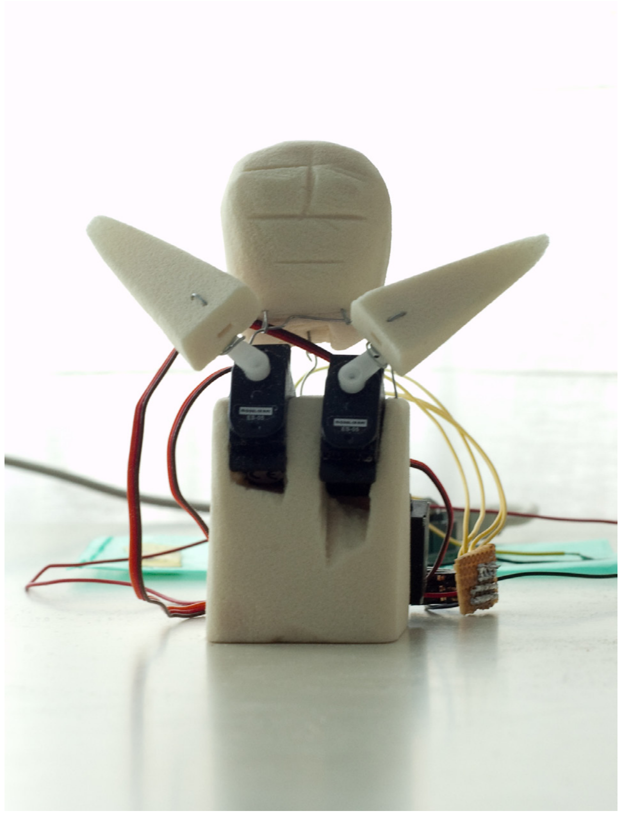


Fig. 31 - Early prototype.

Fig. 32a - Sideview of prototype.

Fig. 32b - Rearview of prototype.

§ 5.2 - Prototype

In the introduction and project objectives it was already stated that creating a prototype was one of the main objectives at the end of the project. Of course this prototype has to serve a goal. Within the context of the project it was built for three purposes; (1) the process of prototyping requires extensive detailing and thus helps the development process, (2) it can be used for evaluation of the design concept and process and (3) personal development goals. While initially the idea was to do more on form development, during the process it has been chosen not to work out the form in detail (as explained in § 4.8). So for this working prototype the external form doesn't look very matured or developed. This was done on purpose as not to confuse my intends here.

Fig. 32c

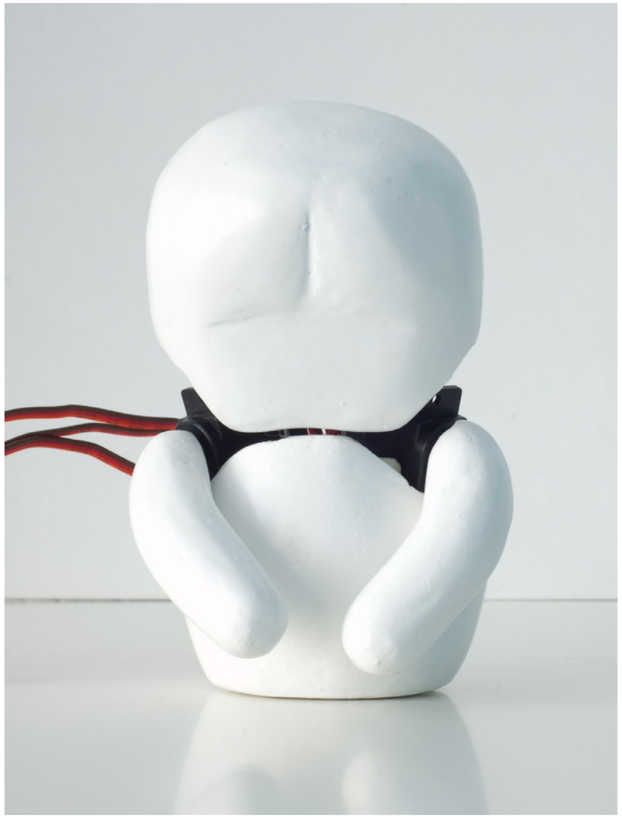


Fig. 32d

Fig. 32e

Positive gesture

head and hands are up

Negative gesture

head and hands are down

Alerting gesture

head up and hands are halfway waving

5 Final design

To reduce the visual clutter of an Arduino, servo-motors and various cables these were concealed by having the endings on the backside, with the Arduino hidden inside a fake TomTom Start casing. The Start is TomTom's PND offering aimed at a younger / entry demographic. The structure resembles the idea lined out in § 4.7 on placement, having the PND and agent closely together. Eventually it is intended that the software runs along with the TomTom PND and that the physical agent listens to status updates coming from the mother-device. This implies that the heavy lifting in terms of data processing isn't done by the agent itself, reducing the need for processing and memory capacity, ultimately lowering production costs for this product.

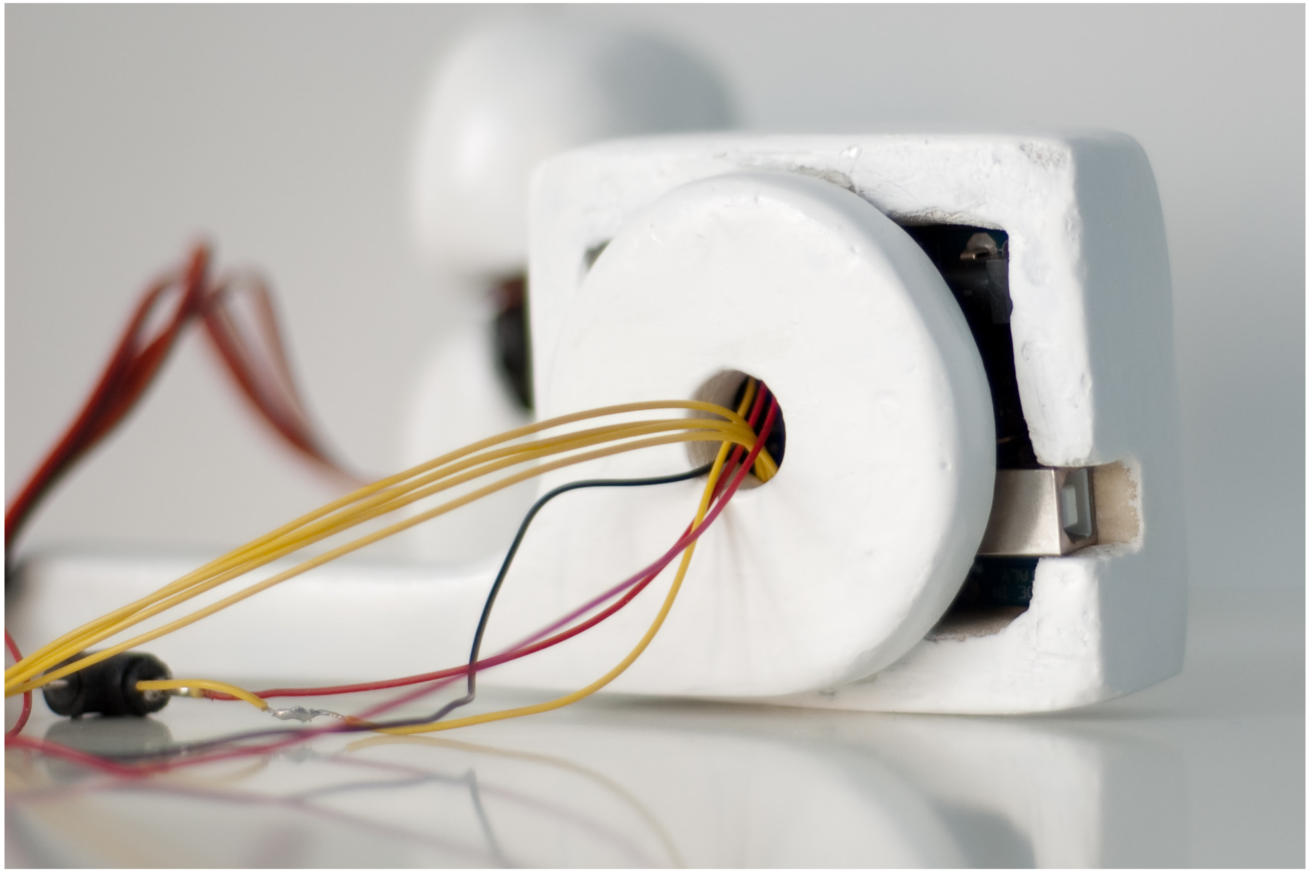


Fig. 33 - Backside of PND mockup, where an Arduino microcontroller is hidden.

Technology

The figures show an earlier development prototype and the final prototype. The prototype has been built using three small servo-motors that drive the head and both arms. In turn these servo-motors are controlled by an Arduino microcontroller. The Arduino is set up to communicate via its serial / USB connection with other software. Basically the Arduino can be told to evoke a certain gesture from the external program. This external program can be everything, as long as it follows the simple protocol I've created. In this case Processing code has been used to feed the Arduino.

Fig. 34 - View of prototype with TomTom Start-sized mockup in the background. The mockup provides a hide for the electronics while illustrating that the agent is designed to be connected with a TomTom product.

6.1 Conclusions

For the client TomTom, this FBP project aimed to design a product that actively engages to influence the behaviour of a car driver. Whereas the TomTopportunities project had a decidedly broad perspective, this instance of the project took a more focused approach from the beginning. From the very start my personal interests were related to influencing behaviour.

Because TomTom targets the individual drivers and not traffic as a whole, a suitable area of interest was found in safety related to young drivers. Focusing on safety seems a good choice in tandem with the focus on young drivers. These drivers face higher risks than other drivers for various reasons.

This project then aimed to reduce the safety disadvantage initially by focusing on the risk perception. If this allegedly biased risk assessment of young drivers could be influenced for the better, unsafe driving would be reduced and so will be accidents. The persuasion of the project's design is directed towards better understanding of the risks taken and it hopes to trigger positive effects. This project proposes a persuasive robot linked up to a TomTom product, that warns ahead of potentially dangerous situations and gives the young driver feedback on performance. It does so by making a range of gestures appropriate for the conveyed messages. Research suggests considerable safety effects could be obtained using such socially embodied feedback.

The project succeeded in delivering such a design proposal, but it must be stressed that this design is by no means market-ready. Although considerable effort went into detailing the workings and reducing ambiguities, there's still work to do. Also, the final design which was materialised in a working model has not yet been tested for effect size. Similar projects do show such effects so tentatively speaking it seems likely this design will also see such effects. Reasons for not carrying out such evaluation are twofold. Within the timeframe that was left a user study could not be made to reliably assess safety, risk perception and user satisfaction effects.

To clarify the value this project may hold for TomTom, we need to look at the business case of the company. My view of TomTom is that of a software company which sells this software either alone or as part of a package. Once a growth market with few competitors the car navigation market has matured with fiercer competition and decreasing margins. This asks for diversification based on TomTom's strengths. This concept specifically aims at the driver experience largely based on map and live data. It differs by being a physical product, not just software. Still it is as good a match with TomTom values such as aiding driving, safety and fostering a driving companionship. This project should thus be seen as exploring an opportunity for TomTom to diversify their portfolio. Based on the findings there sure is something to it.

Opportunities 6.2

On this page I will discuss some issues that did come across during the project, but that were deemed too far away from the scope to be included. These things may however be of interest to readers of this report.

During the literature research on persuasion, operant condition (reward and punishment schemes) and related psychological theories I wondered on what level persuasion from a social actor may work. Is this persuasion integrated into the personal norm or is it more like social pressure? Relevant here is the so-called Theory of Planned Behaviour, originally developed by Ajzen. To be short, this theory says people form an intention to behave based on three types of attitudes. The three types are personal attitudes, social attitudes and perception of control over the behaviour. Maybe it's because a product that seems to have social qualities that it can tap into the social norm, which would explain the increases effects. Or maybe this theory isn't suited for affective systems at all. Given my intended switch to Human-Technology Interaction I find this combination between psychology and interaction very interesting.

Less theoretical are alternative use incentives and business models for this concept. In this report it was argued that young drivers or their relatives and friends would buy a the persuasive driving aid and then go on to use it. Providing such products via an insurance company could change the game, because the evaluative nature of this concept could be used to set the insurance rates and no-claim rates. It means the use incentive changes or is extended from intrinsic motivation to be a safe driver towards saving money by behaving safely. It could be interesting to see the effects here, both in terms of driving style and the role of the product. Of course it implies a different rationale to the design, because for determining the risks taken by a driver just the global average would be enough. That's a radical change with the aim of the project (backed by user feedback) to focus on immediate feedback and results. For TomTom this business model would provide a diversification, albeit at the cost of making their products tamperproof.

Related to previous opportunity would the availability of the evaluative feedback on social platforms, such as Facebook, Twitter and Hyves. These platforms provide external developers the opportunity to tie-in their software with people's online pages. Perhaps a social competition (who's the safest driver? shame on him!) can help the cause. Again, here may be social and privacy related issues that need tackling.

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Resources 6.3

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Appendix A Criteria Matrix

The table in this appendix forms a matrix with various selection criteria to differ the concepts of phase 2. These criteria are categorised by concept criteria and stakeholder criteria.

Values are limited to --, -, + and ++. No undecided values are used. Except, when no clear values are available the cells are left blank. In the case of preliminary conclusions the values are between paratheses.

	Persuasive Agent	Speeding Awareness	Review
Conceptual criteria			
Concept involves user	+	--	+
Intuitive	++	--	+
Social element	++	+	--
Usable while driving	+	+	--
Anticipated effect	+	-	+
Leads to insight	+	+	++
Helps reflection	-	+	++
Preventive feedback	++	+	--
Feedback is concrete	--	-	++
Feedback continuously available	-	++	--
Feedback available in hindsight	--	-	++
Distractions	--	+	++
Standalone	++	-	--
Complexity	--	++	+

(Continued on next page)

Criteria Matrix **Appendix A**

	Persuasive Agent	Speeding Awareness	Review
User criteria			
Willingness to use	(+)	(+)	(-)
Believe in effect	(+)	(+)	(-)
Desirability of concept	(+)	(+)	(-)
Pleasant use experience			
Client criteria			
Fit with strategy			
Business value			
Ties in with expertise			
Adds to company image			
Development potential			
Interaction design	++	+	-
Interactive prototype	++	+	++
Integrating tech	++	+	-
User testing	+	++	-
User feedback	++	++	-
Form & senses	++	+	--
Business design	++	--	+
Daring idea	+	--	-
Fit with identity	+	--	-

Appendix B User survey

At the end of October an online survey was composed and send out to potential respondents. These people (mostly students and friends) were reached via e-mail and Hyves.

A total of 107 people responded, which is a large enough number to base decisions on the outcomes. Of these respondents 63 % was male and 37 % female. There is a strong bias towards higher education levels, stemming from how participants were reached. Median age was 21, with only six respondents outside the young drivers age group. On average people possessed a driver's license for about three years. Around 25 % of the respondents didn't possess a driver's license.

Apart from the demographics named here, respondents were asked about their experiences in a car (both as a passenger and driver), their view towards safety and driving advice preferences. In short, this survey aimed to get a pretty good view of who the target group is and what they think and prefer with regard to the project's topic.

Because the survey is really extensive with over 35 questions and responses ranging from simple yes / no answers to matrices filled in, plus various open textual responses it's not very well suited to be put to paper. Instead, the report is available online for review:

www . sinds1984 . nl / dump / SurveyReport . pdf