

## Let's Negotiate with Automation

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# Let's Negotiate with Automation: How can Humans and HMIs Negotiate Disagreement on Automated Vehicles?

Soyeon Kim  
Department of Human-Centered  
Design, Delft University of  
Technology, The Netherlands  
S.kim-4@tudelft.nl

Elmer van Grondelle  
Department of Human-Centered  
Design, Delft University of  
Technology, The Netherlands  
E.D.vanGrondelle@tudelft.nl

Ilse van Zeumeren  
Department of Human-Centered  
Design, Delft University of  
Technology, The Netherlands  
I.M.vanZeumeren@tudelft.nl

Alexander Mirnig  
Center for Human-Computer  
Interaction, University of Salzburg,  
Austria, and Center for Technology  
Experience, AIT Austrian Institute of  
Technology, Austria  
Alexander.mirnig@plus.ac.at

Kristina Stojmenova  
Faculty of Electrical Engineering,  
University of Ljubljana, Slovenia  
kristina.stojmenova@fe.uni-lj.si

## ABSTRACT

In automated vehicles, the driver and the vehicle make a decision on the driving. However, there is no guarantee that drivers always agree or follow the system's decision. Drivers can reject the system's proposal or regain control, and it reduces the usefulness of automated vehicles. When a decision conflict happens, the vehicle can negotiate with the driver. Human-human communication depends on the individual's attitude and situation. Similarly, the negotiation style needs to differ depending on the context of conflict and the cause of disagreement. In this workshop, we address the negotiation approach to designing HMI and discuss considerations for applying the human-human negotiation style to human-automated vehicle interaction design. HMI design using a negotiation approach can address the decision conflict between humans and automation and expect enhancing trust and acceptance.

## KEYWORDS

Automated driving, Human-machine interaction, Negotiation, Design thinking

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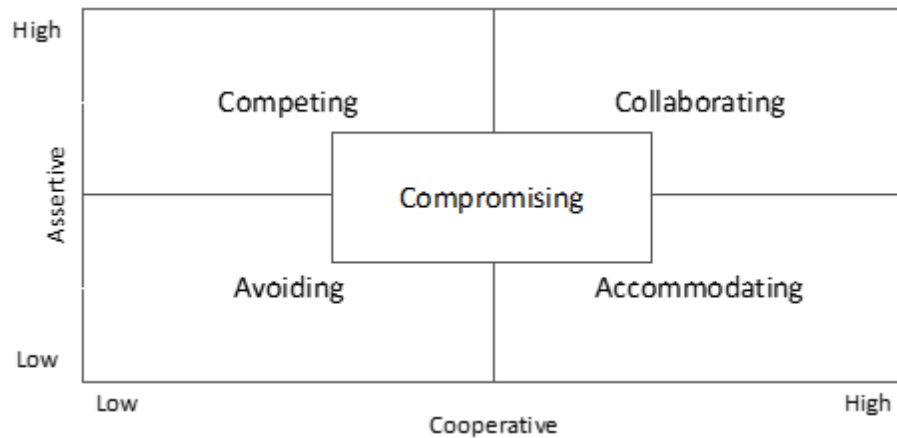
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## 1 INTRODUCTION

As vehicle automation becomes more and more sophisticated, vehicles perform an ever-increasing share of drivers' control and monitoring roles. Drivers are traditionally used to make all of the driving-related decisions in conventional, non-automated vehicles. In automated vehicles (AV), the automation system also participates in the decision-making. (e.g., speed changes during automated driving, or automation proposed to driver transition to a higher automation mode). However, there is no guarantee that drivers would always agree with or follow the system's decision – much like a human co-driver might not always agree with the driving and strategic decision of the human driver in the driver seat. As a consequence, drivers might want to reject the system's proposal or regain control that was entrusted to the system. Since vehicle automation systems are developed for safety and comfort, their usefulness in these two regards can be assumed to decrease the more drivers opt not to use them. Human-machine interfaces (HMI), as the mediating instance between the human and the vehicle, can aid in facilitating the exchange between both parties and assist in such negotiation situations.

In this workshop, we want to address designing driver-AV interactions from a negotiation approach. Negotiation is defined as a procedure of conflict management for resolving opposing preferences between parties to reach an agreement [1]. An automation system and a driver negotiate when exposed to a situation in which the driver does not want to follow the system recommendations or intentions for any reason. In person-to-person negotiations, when making suggestions or persuasions, the communication way varies depending on the situation and the individuals' attitudes towards it. In this workshop, we would like to explore applying this negotiation approach when designing in-vehicle interactions: consider the conflict situation, the cause of the occurrence, and the negotiation style. Previous AV HMI studies [2-5] have designed interfaces focusing on the information contents and the delivery channel. The negotiation approach is expected to apply the results of these studies by understanding the interaction between drivers and vehicles from a different perspective.



**Figure 1: Human-to-Human Negotiation style**

The challenge of driver-AV interaction lies primarily with two factors elementary to any interaction between humans and novel technologies: acceptance and trust. Achieving appropriate driver trust is crucial in negotiating to embrace automation safety and comfort benefits. A critical factor in achieving user acceptance is to find a balance between actual driver autonomy and automation directive actions. HMI's success depends on its ability to promote driver autonomy [6]. When there is a preference (decision) from a system, negotiations are necessary if it contrasts with the driver's preference (decision). Persuasive or seductive negotiations resolve the conflict by allowing the drivers to follow the system on their own. Research is needed to understand drivers' value and design persuasive and seductive negotiations for safety or comfort-related situations.

The driver's trust and acceptance of the system are biased by demographics [7], previous experience, and other information. Drivers underestimate the system's capability and think their driving skills are better than the technology. (There is also the opposite, but the workshop will only cover the above cases.) Humans also have a desire for control. Believing that humans are in control of what happens is an essential part of mental health, although that is not always true. The primary reason for AV development is that the human factor is a contributor to 95% of all road accidents, with driving behaviour identified as the most significant one [8, 9]. If the drivers overestimate their skills, the impact of the information provided to increase trust and acceptance will be insignificant. Therefore, we would like to explore how we can solve the situation with a negotiation approach.

Humans have different communication styles. The way people communicate is also translated into how they negotiate. Thomas[10] acknowledges five human negotiating styles; competing, collaborating, compromising, avoiding and accommodating (Figure 1). Negotiation between vehicle and driver cannot be the same as a human-to-human negotiation. Drivers and vehicles are not in an equal position in negotiations. Drivers do not have to negotiate with the vehicle, but the vehicle has to negotiate in many ways to persuade and seduce drivers. We need to understand the

difference between vehicle-to-driver and human-to-human negotiations and study how negotiations should be designed in vehicles.

## 2 WORKSHOP GOAL AND OBJECTIVES

The overall goal of this workshop is to investigate a negotiation approach for automated vehicles' HMI design and discover how to apply it in such vehicles. To reach this goal, our workshop will address the following objectives:

- Obtain awareness of the possibility of conflicts in HMI design between humans and smart systems
- Form a common sense of the challenging decision, control & communication conflict that arises with the advent of autonomous vehicles.
- Understand the various scenarios and reasons for decision conflicts
- Design and propose promising negotiation ways to facilitate driver interaction in autonomous vehicles through idea exchanges.

## 3 WORKSHOP OVERVIEW

### 3.1 Schedule

The workshop will be a half-day program and will cover the following agenda points: 1) Introduction, 2) Ignition Talk, 3) Creative Exchange 1, 4) Creative Exchange 2, and 5) Discussion.

1) Introduction (70 minutes including break time)

The workshop begins with a short introduction by the organizers and participants. There is an ice breaking experiment to have a common sense of negotiation in automated vehicles. Participants experience the complexity of non-binary negotiations from different perspectives.

2) Ignition Talk (20 minutes, including questions)

We will talk to set the stage for a general approach to negotiation and decision conflict. It raises the possibility of how the negotiation approach can be used in the AV HMI design stage.

3) Creative Exchange 1 – Empathize & Analyze (60 minutes including break time)

This session will focus on designing promising approaches to particular challenges. Participants discuss ideas based on a list of tasks prepared by the workshop organizer. The discussion will be conducted in groups. Each group discusses scenarios when the drivers do not follow the automation's decision and analyze the driver's behaviour. Participants will analyze the conflicting behaviour according to the com-b model to understand behaviour-owner(driver). The expected outputs from group works are a list of scenarios in which decision conflict can happen and the reason for each conflict scenario.

#### 4) Creative Exchange 2 – Ideate & Create (60 minutes)

Participants discuss how the negotiation method can be applied as HMI (Ideate). Participants role-play to experience negotiation methods. In role-play, participants try different negotiation styles with a driver in a particular scenario and analyze what efficient communication is. Then, each team gathers to ideate how the negotiation applies to driver-automation negotiation and creates HMI solutions. After, each team will present a solution approach, and participants will discuss it together.

#### 5) Discussion (30 minutes)

Participants discuss the requirements associated with the task. The focus will be on considering 1) how driver-Automation negotiations through HMI should be different from human-human negotiations and 2) how HMI should be differentiated depending on the context, cultural difference, and personalization.

### 3.2 Expected outcomes

After the workshop, we have a number of decision situations and the HMI ideas pursuing the negotiation approach. We will integrate the outcomes and publish them on the workshop website short-term. The long-term goal is to extend the outcomes based on in-depth studies, present them in an open-access paper for higher visibility and greater accessibility, and lead to further projects such as special interest groups or additional workshops. The negotiation approach for HMI design enhances trust and acceptance while supporting the usefulness of autonomous vehicles, thus contributing to the unique field user experience of autonomous vehicles. Eventually, we want to raise the awareness that the negotiation approach can be applied not only to autonomous vehicles but also to interaction designs with smart systems such as AI and robots.

## 4 SHORT BIOGRAPHY OF THE ORGANIZERS

Soyeon Kim is a Ph.D. candidate in the Department of Human-Centered Design at TU Delft. She brings several years of experience in UX from Hyundai/Kia Motors in South Korea before joining the academy. Her current research is HMI design in automated vehicles, focusing on trust and situational awareness.

Elmer van Grondelle is an associate professor in Advanced Automotive Design at Delft University of Technology, Faculty of Industrial Design, with a vast experience in automotive and strategic design, branding and brand portfolio management. Next to his involvement in short-term projects on partially autonomous vehicles, his long-term research interest concerns the rationalization of automobility in an industry who's reason of being lies in emotional brand values. Elmer is one of the founders of the mobility|society initiative.

Ilse van Zeumeren is an HMI design researcher in the Department of Human-Centered Design at TU Delft. She has multiple years of experience in designing for behaviour (change) in the field of mobility; both in direct interaction between (automated) vehicles and humans as well as designing for indirect decision making during, or before using type(s) of mobility. She is responsible for the HMI design for the communication of different levels of automation in one drive, for the European project Mediator.

Alexander Mirmig is a Senior Researcher at the University of Salzburg, Department of Artificial Intelligence and Human Interfaces, and a Scientist at the AIT Austrian Institute of Technology, Center for Technology Experience. He has extensive experience in researching the interaction between humans and automated vehicles, with a specific focus on transitions between manual and automated driving modes, trust in technology, and machine ethics.

Kristina Stojmenova is a Research Associate at the Faculty of Electrical Engineering, University of Ljubljana. Her field of research is in-vehicle human-computer interaction. She is mainly focusing on assessment of driver behaviour and driver's cognitive load modelling, with the use of biometric and driving performance data.

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