SEVENTH FRAMEWORK PROGRAMME

EUROPEAN COMMISSION
DG Communications Networks, Content & Technology

SEVENTH FRAMEWORK PROGRAMME
INFORMATION AND COMMUNICATION TECHNOLOGIES

Coordination and Support Action
Grant Agreement Nr 610737

VRA NETWORKING IN AUTOMATION

Support action for Vehicle and Road Automation network

Human Factors for Vehicle and Road Automation deployment: Needs and Recommendations

Deliverable no.	D 3.5.1
Dissemination level	PU
Work Package no.	WP3
Main author(s)	Johann Kelsch, Anna Schieben, Natasha Merat, Nick Reed
Co-author(s)	
Version Nr (F: final, D: draft)	1.1 F
File Name	VRA_150909_WP3_D3.5.1_Deliverable_on_Human_Factors_v1.0.docx
Project StARTS Date and Duration	01 July 2013, 42 months

Document Control Sheet

Main author(s) or editor(s): Johann Kelsch, Anna Schieben, Natasha Merat, Nick Reed

Work area: WP3

Document title: Human Factors in Vehicle and Road Automation: Support Actions, Needs and Recommendations

Version history:

Version number	Date	Main author	Summary of changes
0.1	24.07.2015	Johann Kelsch	Compiling first draft version based on a provided template
0.2	02.09.2015	Johann Kelsch	Further content added
0.3	09.09.2015	Johann Kelsch, Anna Schieben, Natasha Merat	Consolidation and further content added
0.4	24.09.2015	Nick Reed, Johann Kelsch	Consolidation and further content added
1.0	06.11.2015	Johann Kelsch, Anna Schieben	Further consolidation, internal review and further content added
1.1	09.11.2015	Johann Kelsch	Executive summary added

Approval:

	Name	Date
Prepared	Johann Kelsch, Anna Schieben, Natasha Merat, Nick Reed	06.11.2015
Reviewed	Johann Kelsch, Anna Schieben, Davide Brizzolara	06.11.2015
Authorised	Maxime Flament	09.11.2015

Circulation:

Recipient	Date of submission
EC	09.11.2015
VRA consortium	09.11.2015

Table of Contents

Table of Contents 3

List of Figures 4

List of Tables 5

1 Executive Summary 6

2 Introduction 7

2.1 Intended Audience 7

2.2 Structure of Document 7

2.3 VRA contractual references 8

2.4 Project Objectives 8

3 Human Factors challenges and needs in the deployment of vehicle and road automation 9

3.1 Challenges and necessary future developments 9

3.2 Stakeholders tree 9

4 Methodology and tool description for Human Factors needs for deployment of ARTS 12

4.1 Face-to-face meetings, congresses, forum, phone and web conferences 12

4.2 Trilateral activities 12

4.3 Links to activities with on-going R&D projects 12

4.4 Links to activities with task forces or interest groups 13

4.5 Human Factors-related webinars 13

5 Report of the networking activities 14

5.1 Building a network for discussion groups and current status 14

5.2 Current status of the discussions 14

5.3 Main outcomes of the work done 14

5.3.1 Short-term recommendations for the EC 16

5.4 Next steps 18

6 Consolidation of the discussion topics 19

7 Conclusions 21

8 Annexes 22

Annex 1 – Face-to-face meetings 22

Annex 2 – Phone and web activities 24

Annex 3 – Trilateral meetings 26

9 Sources 27

List of Figures

Figure 1: Illustration of stakeholder groups and their role vehicle and road automation 10

Figure 2: Illustration of a recommended roadmap for considering Human Factors related topics for development and deployment of ARTS.....20

List of Tables

Table 1: Stakeholder tree identification and description 10

Table 2: Face-to-face meeting activities involving HF-related discussion topics 22

Table 3: Phone and web activities involving HF-related discussion topics.....24

Table 4: Trilateral activities involving HF-related discussion topics.....26

1 Executive Summary

Current and further deployment of automation in vehicles and on European roads may lead to paradigm shifts in the way we live and use mobility. Vehicle and road automation will have an impact on many aspects from the society to single humans from safety to efficiency, from productivity to quality of life and sustainability of our environment. Transition towards this new situation with respect to the automation in our vehicles and on our roads happens gradually. Different migration scenarios will be investigated and deployed resulting in mixed traffic scenarios. For each of them the expected evolution of vehicles, road infrastructure and management should be investigated.

Based on these trends, the role, authority and responsibilities of human drivers equipped and non-equipped with new automation technologies, pedestrians, cyclists, traffic managers, vehicle manufacturers, road operators and mobility service providers can change as well. All these groups can be involved into the same value chain as well as in to the same global automated traffic system. Therefore, all these groups have to deal with human factors related issues, such as fears, trust, human error, workload, stress etc. but also with the new opportunities to use cooperative or adaptive capabilities of humans and groups of humans on the positive side of human factors. The related human factors to be investigated behind the deployment of vehicle and road automation will be described in this document.

In the first year of the project the focus was on interaction with stakeholders in the iMobility Forum and outside of it in smaller local networking activities in order to build a solid base of participants for future discussions. In the second year the focus was to interact with a larger group of stakeholders on the international level in trilateral meetings as well as to use the already implemented network to discuss the most important human factors issues we will be facing while deploying vehicle and road automation. The results of these discussions including the short-term recommendations to the European Commission (EC), such as investigating road user behaviour in the context of heterogeneity of mixed traffic, automated vehicle mode transitions, are presented in this document. These results have been already well received by the EC considering them in current work program 2016-1017.

In the last third year we are aiming at stabilizing the network on human factors experts and other stakeholders across Europe and on the trilateral side between EU-US-Japan. The already elaborated results will be further consolidated and placed in as appropriate anticipated order into a roadmap. The further work towards network stabilization, consolidated results as well as the roadmap will be presented in the final document at the end of the project and used in parallel to discuss and to develop further short- and mid-term recommendation to the EC regarding smooth deployment of vehicle and road automation.

2 Introduction

Human Factors (HF) research in vehicle automation focuses on understanding the interaction of humans with all aspects of an automated road transport system (ARTS) and its effects. We use the term ARTS for systems consisting of humans, intelligent infrastructure and automation that can provide different levels of automation in one vehicle as well as for vehicles that can be driven completely automated and driverless.

There can be three perspectives to look at ARTS. Humans *interact* with automated vehicles and intelligent infrastructure when taking the role of a driver/operator or passenger from *inside* the automated vehicle. In addition, humans interact from *outside* with them as road users, such as pedestrians, cyclist and other technically equipped and unequipped traffic participants using the same traffic environment. Traffic managers can *coordinate* ARTS from the *top view*. For all perspectives HF expertise is highly relevant for managing the process of safe implementation of ARTS in the near future. In the longer term, when automated vehicles are common on our roads, HF research remains important to explore the effects of automated vehicles on humans and to derive knowledge and recommendations how to improve the design of ARTS.

In work package (WP) 3.5 we aimed to support HF-related work in the context of ARTS. As input for the WP we used the discussions of the HF professionals and other experts in the VRA project and the iMobility Forum during face-to-face meeting and conference calls. Fruitful interactions with other WPs of the VRA project was considered and developed further. International collaboration, such as the cooperation between EU-USA-Japan, was supported by the participation of the members of the WP in trilateral meetings and in further networking events to discuss international needs and activities in research on HF for ARTS.

The results of the WP are presented in this document. It provides a summary on HF for ARTS associated with the needs, recommendations and support actions undertaken in the VRA-project as well as in the related iMobility Forum and trilateral discussion group. It provides HF-related recommendations and a road map for the EU Commission on topics of future HF research in the context of ARTS.

2.1 Intended Audience

This document is written mainly for the following audience:

- European Commission
- Partners and associated partners of the VRA-Project
- Interested researchers in the HF community

2.2 Structure of Document

The deliverable consists of the following sections:

- Section 1: Introduction
- Section 2: Human Factors challenges and needs for the deployment of vehicle and road automation
- Section 3: Methodology and tool description for Human Factors needs for deployment of ARTS
- Section 4: Report of the networking activities

- Section 5: Consolidation of the discussion topics
- Section 6: Conclusions
- Section 7: Annexes

2.3 VRA contractual references

VRA, Vehicle and Road Automation, is a Support Action submitted for the call FP7-ICT-2013-10. It stands for *Vehicle and Road Automation Network.*

The Grant Agreement number is 610737 and project duration is 42 months, effective from 01 July 2013 until 31 December 2016. It is a contract with the European Commission (EC), Directorate General Communications Networks, Content & Technology (DG CONNECT).

The EC Project Officer is:

Myriam Coulon-Cantuer
EUROPEAN COMMISSION
DG CONNECT – UNIT
Office BU31 06/17,
B-1049 Brussels
Tel: +32 (2) 29 94156
E-mail: Myriam.Coulon-Cantuer@ec.europa.eu

2.4 Project Objectives

In the field of vehicle and road automation, VRA's main objectives are:

- To maintain an active network of experts and stakeholders
- To contribute to international collaboration
- To identify deployment needs
- To promote research and deployment initiatives

In practice, VRA will:

- Organise or support international meetings together with similar initiatives in US and JPN. (WP2.1)
- Support the iMobility Forum Automation WG and extend its role as a reference group for European activities on the topic eventually formulating common positions, especially at European level (WP2.2)
- Aggregate information on existing research or deployment activities in a shared wiki (WP2.3)
- Describe valid business models and deployment paths & scenarios and investigate the broad socio-economic implications of automation for the future societies (WP3.1)
- Clarify, report and setup a plan of actions on legal, liability, insurance and regulatory issues in different member states (WP3.2)
- Monitor and steer standardisation, compliance and certification for vehicle and road automation (WP3.3)
- Contribute to the discussion on relevant topics for the deployment of Vehicle and Road Automation: Connectivity (WP3.4), Human Factors (WP3.5), Digital Infrastructure (WP3.6), Evaluation of Benefits (WP3.7) and Decision and Control Algorithms (WP3.8).

3 Human Factors challenges and needs in the deployment of vehicle and road automation

As humans are and will remain an essential part and main beneficiary of ARTS, supporting HF research in the context of ARTS is a crucial need when addressing the deployment of safe, efficient and comfortable automated road transport systems. This involves considering the role of humans not only as drivers of automated vehicles, but also as pedestrians, cyclists and drivers of other technically equipped and unequipped vehicles interacting with automated vehicles and intelligent road infrastructure. As the smooth integration of humans in a technical environment can be a difficult task, interaction of humans with ARTS can cause challenges. Research is therefore required to ensure the safe deployment of vehicle and road automation. Those challenges and needs are discussed in this section.

3.1 Challenges and necessary future developments

Recent technological developments, such as v2x, advanced sensors and automation technologies, allowing for a distributed knowledge bring new HF challenges of exploring and designing the information distribution and collaboration between different traffic participants. In order to address these issues appropriately, consideration of HF is crucial from the beginning of a system development process until the system usability and field operational tests. Knowledge and theories from (social-) psychological and behavioural sciences can be used to understand how humans interact with ARTS.

The resulting knowledge on human interaction within ARTS can be used to optimize the interaction design and the technical design of ARTS with the goal to maximise safety, efficiency and user satisfaction. It can raise the usability and acceptance of ARTS and therefore support the deployment of ARTS to the global markets.

3.2 Stakeholders tree

The stakeholders to be taken into account in vehicle and road automation can be divided into four big categories: technology providers (e.g.: OEM´s, GNS suppliers, research and consulting), service providers (highway operators, assurance companies), decision makers (e.g.: local and national authorities, certification bodies) and final consumers (e.g.: drivers associations, logistics operators). Following the distinction of roles for VRA, the stakeholder groups are illustrated in Figure 1. The four sides of the rectangle represent these four roles.

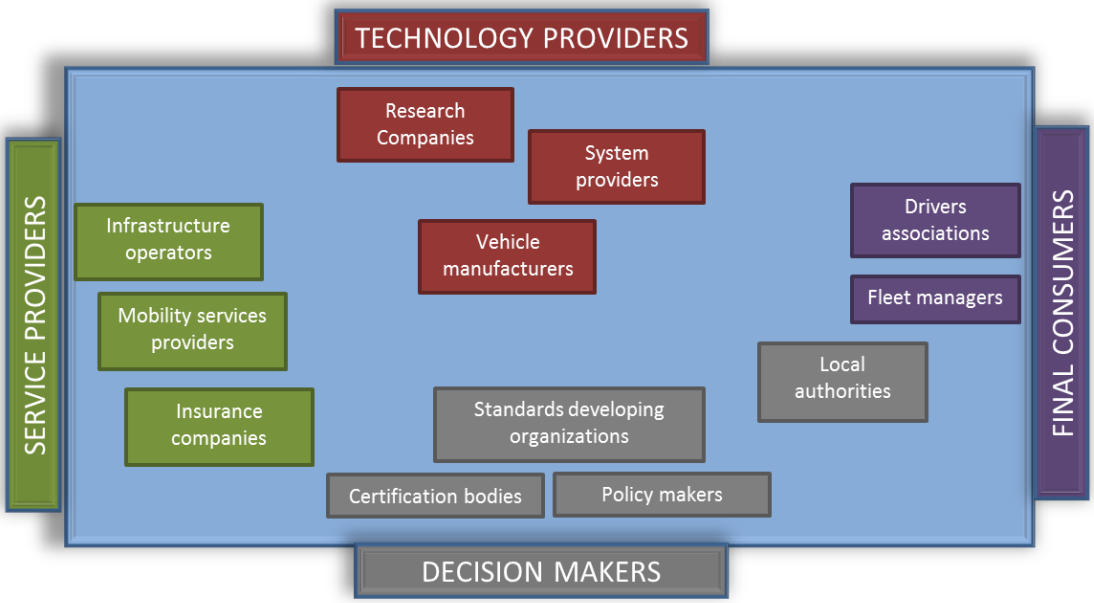

Figure 1: Illustration of stakeholder groups and their role vehicle and road automation

This general overview is customized in Table 1, in which the stakeholders are analysed indicating main function and also key aspects on standardization and certification that are affecting them. This is important to focus the discussions depending on the group of stakeholders that VRA is addressing at each moment.

Table 1: Stakeholder tree identification and description

Stakeholder	Function	Themes
Policy makers and legislative bodies	Produce regulations and ensures compliance	• Deployment of ARTS brings an important number of Human Factors questions regarding safety and efficiency of such systems, which can be supported and improved by appropriate legislation decisions
Vehicle manufacturers	Manufacture and sell vehicles with a level of automation	• Human factors effects and HMI equipment affect vehicle manufacturing procedures
System providers	Offer VRA related systems and applications for vehicles and infrastructures	• V2X and HMI equipment (both for vehicles and for roadside units) following standards to ensure a proper usability of ARTS
Research companies	Provide new paradigms and application solutions. PARTS of the technology providers chain	• Identify gaps in existing Human Factors concepts and requirements for the needs of automated driving • Derive HMI strategies out of

		Human Factors knowledge
Service providers	Make business providing services based on vehicle and road automation	• Enhanced services with high acceptability and usability exploiting Human Factors findings
Infrastructure operators	Explode roads and highways. Is a potential service provider	• Support the installation of intelligent infrastructure extending the palette of useful and acceptable by humans automation applications
Final consumers	Buyers of VRA technology (drivers, fleet owners, local authorities, ...)	• Provide list of their needs, expectations and services useful for them while driving enabled by ARTS
Certification bodies	Homologation of vehicles, equipment and drivers for automation	• Certify relevant HMI equipment
Insurance companies	Provide Insurance for automated vehicles. Safe mobility and responsibilities	• Find liability and insurance schemes in case of accidents caused by Human Factors and HMI issues and malfunctions
Standards Developing Organizations	Primary activities in developing, coordinating, promulgating, revising, amending, reissuing, interpreting, or otherwise producing technical standards that are intended to address the needs of some relatively wide base of affected adopters	• Provide new standards or upgrade existing ones to safeguard interoperability between different HMI enabled vendors and products • Standardization of relevant HMI in automated vehicles

4 Methodology and tool description for Human Factors needs for deployment of ARTS

Main tools for stakeholders' engagement and collecting of HF-needs for deployment of ARTS, which are already used in VRA and will continue to feed the discussions, regarding not only HF-related but overall VRA activities, are briefly highlighted below. Inside each one of the following paragraphs apart from the way the respective tool contributes to this deliverable, a short status of how HF-subgroup is using or intends to use this tool is also highlighted.

4.1 Face-to-face meetings, congresses, forum, phone and web conferences

To collect and to discuss the HF-related topics, sub-topics and their implications on development of HF for ARTS, face-to-face meetings are a suitable tool. Therefore, several face-to-face meetings were conducted at different places. In this context, congresses and forums can be used as enablers for parallel face-to-face meetings as well. Table 2 (Annex 1) shows the dates, the meeting places as well as the main HF-related discussion topics.

In order to coordinate and to consolidate discussions and overall work regarding HF-related topics, sub-topics and their implications on development of HF for ARTS, phone and web conferences can be conducted. In the Table 3 (Annex 2) the dates as well as main HF-related discussion topics are collected, which already have been conducted so far.

4.2 Trilateral activities

To coordinate and to distribute the HF-related topics and their implications of developments of HF for ARTS on international level, partners of the VRA HF-related work package participated in several trilateral meetings (EU-US-JP). In Table 4 (Annex 3) the dates, the places and main topics of these meetings are collected.

4.3 Links to activities with on-going R&D projects

Many current and on-going research and development activities are already dealing with HF-related implications on ARTS. Providing sustainable links to these activities can be a useful methodology for distribution and consolidation of HF-related issues in deployment of ARTS. Potential contribution can be expected from the following activities:

- EU-Project D3CoS (Designing Dynamic Distributed Cooperative Human-Machine Systems)
- EU-Project AdaptIVe (Automated Driving Applications and Technologies for Intelligent Vehicles)
- EU-Project InteractIVe (accident avoidance by active intervention for Intelligent Vehicles)
- EU-Projects CityMobil 1&2 (Cities demonstrating cybernetic mobility)
- EU-Project HAVEit (Highly Automated Vehicles for Intelligent Transport)
- EU-Project SPARC (Secure Propulsion Advanced Redundant Control)

- EU-Project AutoNet2030 (Co-operative Systems in Support of Networked Automated Driving by 2030)
- EU-Project Companion (Cooperative mobility solution for supervised platooning)
- Project HFAuto (Human Factors of Automated Driving)

4.4 Links to activities with task forces or interest groups

Links to activities from other HF-relevant task forces or interest groups around Europe and the world can distribute and gain the understanding and acceptance of importance for HF-related needs in deployment of ARTS. Therefore, those links can be useful tools for HF-related work in VRA. In following, some of the groups are enumerated, which can be of high importance for Human Factors point of view on ARTS:

- Members of the VRA-Project
- Members of the iMobility Forum (all Human Factors and HMI-related groups/sub-groups)
- Members of trilateral Human Factors related group (EU-US-JP)
- Human Factors and HMI-standardisation activities, such as RESPONSE, ISO, national activities, such as DIN

4.5 Human Factors-related webinars

A webinar is a good tool to reach a broad auditorium of people interested in HF development for ARTS. It gives the opportunity to interact with participating professionals and other interested people giving their feedback on current relevant topics discussed in webinars. In following, two HF-related webinars are enumerated as examples.

On 28th of March 2014, 14:30-15:30 Brussels time (CET) a VRA webinar: “Long term socioeconomic effect of mobility automation in cities” was conducted. Dr. Adriano Alessandrini (Citymobil2 project Coordinator) shared his view on how the urban ecosystem will change once the road vehicles will drive themselves and what will be the impact of these changes on industry, citizens and urban life-style.

On 10th of October 2014, 15:00-16:00 Brussels time (CET) a VRA webinar: “Human Factors in vehicle automation: activities in the European project Adaptive” was conducted. The speaker was Emma Johansson from VOLVO TRUCKS. The general objective of this Webinar was to present an overview of the on-going and planned Human Factors related activities in the EU-project AdaptIVe following the research carried out in the EU-projects InteractIVe and HAVEit.

Further information about on-going and already conducted HF-related webinars can be found on the VRA website [2].

5 Report of the networking activities

In this section the networking activities are reported.

5.1 Building a network for discussion groups and current status

VRA project provide a good platform to build a network for groups discussing HF-related implication on ARTS.

1. VRA brings HF-professionals from all around the Europe and the world together, helps homogenizing the understanding of the current issues in the HF-domain, develops possible solutions for these issues as well as grows the professional network dealing with similar issues in the similar context. This optimizes the informational acquisition and knowledge generation on international level and helps focussing on the most important HF-related issues towards deployment of ARTS.

2. VRA brings together professionals from different domains which helps sharing the collected important HF-knowledge and activities. Open discussion and group culture in the iMobility Forum Automation WG HF-subgroup showed that professionals being originally not from the HF-domain are joining the group, comprehending the importance of HF-related contributions for development and deployment of ARTS and actively participating by adding fruitful content.

The current status of the HF-subgroup is as follows: We stabilized a ‘core group# of 4-5 HF-professionals and 5-7 ‘floating sub-group members’ are involved in the discussion of HF-related issues within the VRA project.

5.2 Current status of the discussions

In our discussions we focussed on research and development sub-topics important for the future deployment of ARTS from the HF-perspective. Most of the discussions yet done were focussed on collecting the most important categories and sub-categories. In the next section the results of these discussions are summarized.

5.3 Main outcomes of the work done

A number of HF-related research topics needs to be covered for the deployment of safe, efficient and comfortable ARTS, including:

- **Automation effects and implications for drivers:**
  - Use automation to support challenges requested by older/disabled drivers
  - Consider operator workload, distraction, stress, situation awareness, trust in ARTS, fears, confidence, attention, performance while using ARTS
  - Consider changes in operator’s/user’s skills due to the automation
  - Take into account possible misuse/abuse/disuse of the automation
  - Understand new/different tasks due to the higher automation

- **Automation effects and implications for other traffic participants**:
  - Understand implications of ARTS for ‘non-equipped road users’, such as pedestrians
  - Understand implications of ARTS for traffic management
  - Understand implications of ARTS for authorities, society, politics etc.

- **Automation effects and implications for "global players"**
  - Understand how ARTS should/will influence future driver training
  - Develop the market appeal: ('Wow'-Effect)
  - Consider crisis management (i.e. in emergency situations such as fire in tunnels, natural disasters)

- **Human Factors related system design issues:**
  - **ARTS usability**
    - Understand human and user expectations on ARTS
    - Improve acceptance of ARTS for a broad population in different countries
  - **ARTS transparency, e.g. observability of ARTS states and behaviour:**
    - Enhance driver's mental model about the automation
      - Develop effective in-vehicle interfaces for displaying the operation of automated systems
      - Increase predictability of the automation behaviour
      - Consider the limitations and capabilities of ARTS
      - Develop warnings and fall-back strategies in the case of malfunction
    - Improve the automation's "mental model" about the driver
      - Develop methods for river monitoring and driver state assessment
      - Develop and use driver models
      - Consider emotional (affective) states and capabilities of operators
  - **ARTS stability**
    - Consider the controllability of ARTs
    - Consider the delegability of tasks within ARTS
    - Consider relevant factors that allow successful and timely transition of control between the human operator and the automation for the system design
    - Consider the role, authority and task distribution between the driver/operator and automation for the system design

  - **Dealing with complexity of distributed ARTS**
    - Consider the current tendency of systems' distribution vs. necessity of systems' integration due to the requirement of a proper ARTS usability
    - Integrate different system parts considering the driver as a crucial part of the joint driver-automation system
    - Understand the raising social psychological issues within distributed ARTS (e.g. cooperation, competition in control etc.)
    - Understand how the high level of connectivity affects the driver

  - **HMI-Standardisation**
    - Improve compatibility between technical and HF requirements
    - Develop standardisation approaches of assessment procedures
    - Develop standardisation of functionalities, interface elements, automation behaviour

5.3.1 *Short-term recommendations for the EC*

From the Human Factors perspective some recommendations can be given regarding the most relevant research topics when addressing the deployment of safe, efficient and comfortable ARTS out of the VRA discussion. The recommendations can be separated according to the level of automation that is addressed: 1.) SAE [1] Level LoA 2-3 (pARTSial and conditional automation), where the driver is actively involved into the vehicle control and 2.) LoA 4-5, where the driver is only passively (e.g. as fall-back) involved into the vehicle control.

I. Regarding (SAE) Levels of Automation 2-3:

General background: Levels of Automation (LoA) 2-3 are anticipated as already available on the market and as the next short-term developments in highly automated vehicles and road transport systems. Due to the definition (e.g. SAE) that in these LoA the human driver is still involved into the vehicle control, the "classical" Human Factors issues should be addressed by research projects in general. Such issues could be the drivers' expectations and acceptance on automation behaviour, HMI, adaptation, arbitration, attention, trust, usability, cooperation, observability and controllability of highly automated systems. One of the most important points on this spectrum to be addressed is

a. Managing automated vehicle mode transitions

Background: Until fully automated vehicles are widespread, partially and highly automated vehicles will be present in the market offering varying levels of automation for varying proportions of road/journey types. Consequently, the process of engaging and disengaging automation modes must be considered and guidance provided to manufacturers in best practises to provide optimised joint driver-vehicle systems.

Project objectives:

- Investigate drivers' understanding and mental models of vehicle automation, before, during and after mode transitions in order to facilitate authority, role, task and control allocation in joint driver- vehicle system architecture.
- Establish optimised process for handover/resumption of control task based on HF best practice and usability concepts.

Demonstrator:

- Based on suitable and evaluated concepts for transition of vehicle control and task reallocation between the driver and the automation during LoA transitions, demonstrator vehicles should be presented.

Outcomes:

- Produce a European Statement of Principles specifically on Automation HMI to support OEMs and suppliers in developing optimised interfaces.

II. Regarding (SAE) Levels of Automation 4-5:

General background: LoA 4-5 are anticipated as mid- and long-term developments in highly automated vehicles and road transport systems. Due to the definition (e.g. SAE) that in these LoAs the human driver is less involved into the vehicle control, the "classical" Human Factors issues should be extended by the research projects. Such issues could be the effects of (high) connectivity on drivers and cooperation of groups of drivers and other road users, such as non-equipped vehicle users, vulnerable road users, and older or disabled transport systems users. Impacts of highly and fully automated road transport systems on the societal level should be investigated as well. The most important points anticipated on this spectrum are:

a. Investigating road user behaviour in the context of automation heterogeneity across the vehicle fleet

Background: For the next fifty years at least, it can be anticipated that the road vehicle fleet will comprise vehicles with different automation capabilities from no automation to full automation. Vehicle drivers/riders, pedestrians and cyclists may modify their behaviour based on their perception and understanding of the automated/manual driving behaviour of vehicles they encounter. This may be associated with negative safety outcomes and potential disruption of transport systems.

Objectives:

- Investigate road user (pedestrians, cyclists and drivers) behaviour in the context of a vehicle fleet with heterogeneous levels or modes of vehicle automation.
- Investigate how to improve the ways in which automated vehicles can communicate their intentions to other road users so that authority, role, task distribution between driver and automation and manoeuvre actions are in line with human drivers' expectations (and conduct evaluation studies of proposed techniques).
- Investigate opportunities for misuse/abuse of automated vehicles that may result in unanticipated adverse consequences.

Outcomes:

- Produce guidance on optimisation of road transport systems with changing heterogeneous levels or modes of automation over time based on an understanding of road user behaviour in this context and effective, intuitive communication of automated vehicle intention.
- Development of strategies to prevent misuse/abuse of automated road transport systems by other road users.

b. Impact of the new developments of highly automated road transport systems on the (European) population

Background: Personal mobility is associated with improved employment, social and health outcomes. Automated vehicles may change personal mobility for different demographic groups in different ways. These changes may affect employment prospects, social wellbeing, health and the overall performance of the transport system.

Project objectives:

- Review population groups likely to be affected and projections of how demographics will change over the next 20 years. Conduct focus groups with samples of the affected populations to understand what their mobility requirements are and how they could be enabled by automated vehicles.
- Estimate potential benefits and dis-benefits, including employment, health social wellbeing and traffic impacts with the introduction of automated vehicles.

Demonstrator:

- Based on the review and impact assessment, work with a suitable relevant group (e.g. old people's home) to develop a demonstration system that enables evaluation of real world influence on automated vehicles.

Outcomes:

- Assessment of how the development of automated vehicles will affect the European population.
- Guidance on the market in which automated vehicles are most likely to succeed and the types of vehicle that will meet the anticipated demand.

5.4 Next steps

Since HF for ARTS is a relatively novel topic just being step by step accepted and respectively considered in the community of ARTS in difference, for example, to the already mature and broadly accepted engineering topics for development and deployment of ARTS, HF for ARTS needs further steady support actions. The next recommended steps are:

1. Further consolidation of collected HF-related recommendations regarding higher levels of automation to improve the interaction concepts for ARTS according to the current ARTS penetrating the market.
2. Working towards pro-active participation of HF-professionals on standardization activities in the area of ARTS development and deployment.
3. Enlarging the HF-related network activities to the international level, e.g. bilateral and trilateral cooperation EU-JP, EU-US and EU-JP-US.

As the HF-issues in the area of ARTS are independent of the particular country these steps are necessary to grow the professional network to ensure the global success of the HF-related solutions in ARTS deployment.

6 Consolidation of the discussion topics

In the previous section many very important HF-related topics were enumerated and shortly described. As these topics can be highly interdependent, it is necessary to have an idea, how they can be prioritized in respect to the order and therefore to the timeline of considering these topics. On

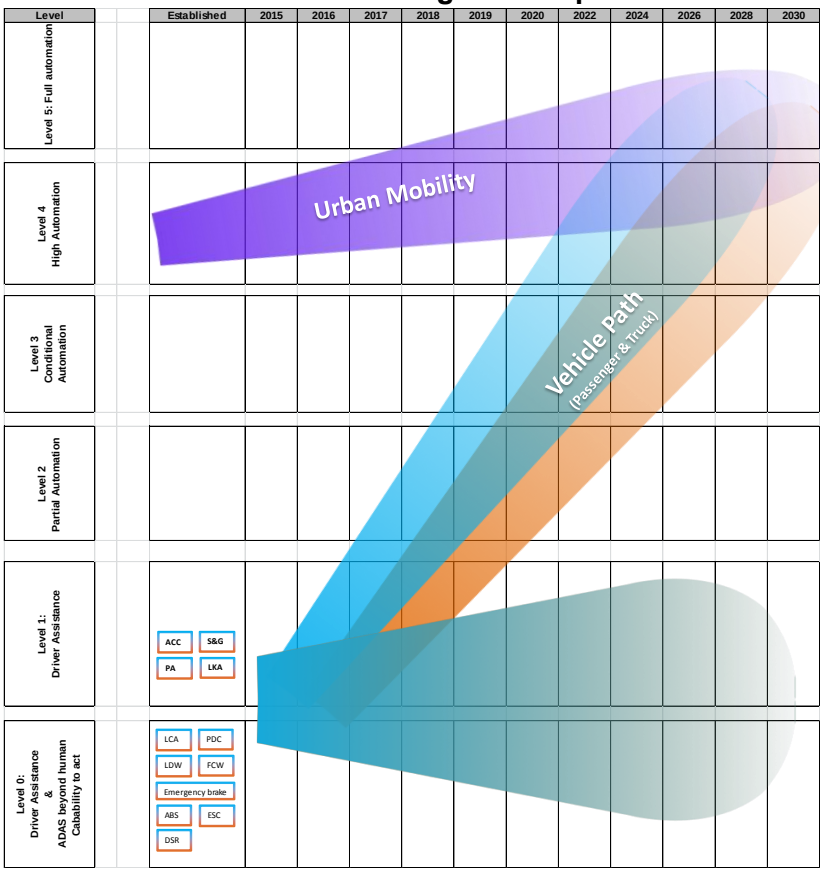

Figure 2 a roadmap for considering Human Factors related topics for development and deployment of ARTS is shown. This roadmap was already homogenizes with other roadmaps available from OEMs and other important stakeholders, such as other iMobility WG Automation subgroups.

The roadmap needs a further discussion and will be available in the Version 2.0.

Timeline	2015				2030
Automated Highway Driving	Definition of some HF issues	Investigation of some HF issues	Implementation, prototyping, etc.	Tests Evaluation, Validation	Availability
Intelligent Intersection					

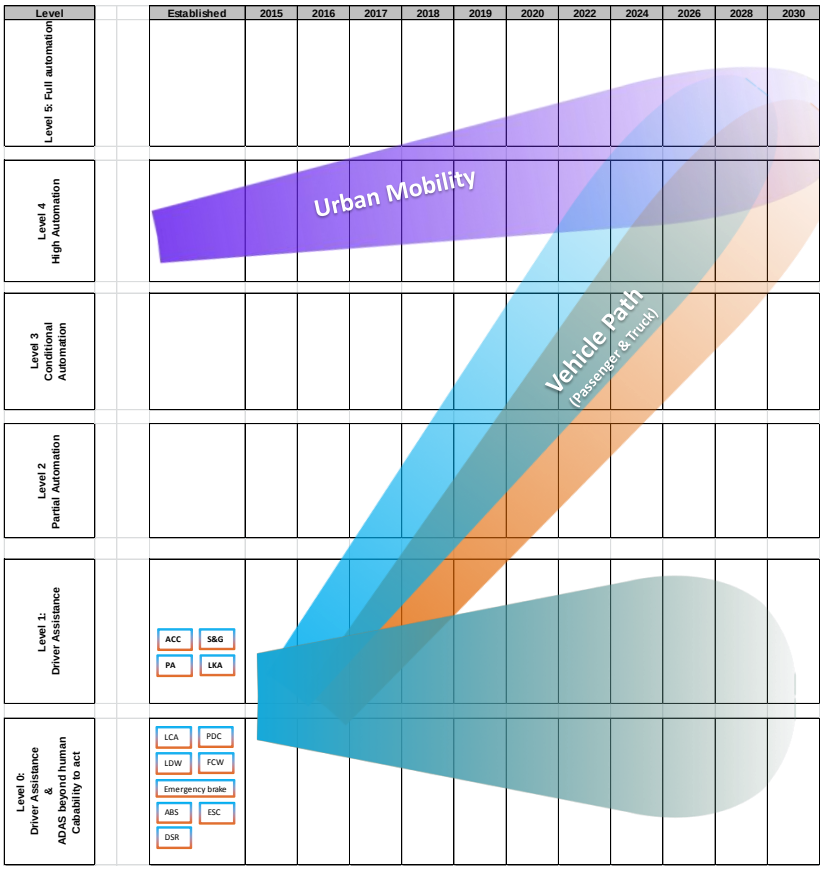

Figure 2: Illustration of a recommended roadmap for considering Human Factors related topics for development and deployment of ARTS

7 Conclusions

The technology required to deliver automation is progressing rapidly. Work is also required to address the legal and liability issues that provide an appropriate regulatory environment for the operation of automated road transport. However, Human Factors is frequently recognised as a critical challenge in the deployment of automated road transport systems to deliver safe, efficient, cost-effective and enjoyable mobility. This is true at all levels of automation from driver assistance systems where driver understanding of system operation is vital up to full automation where system use and interaction with other road users must be optimised.

The Human Factors group within the VRA project has promoted discussion and considered opinions from experts across the continent and exchanged views with similar groups from the US and Japan. This has resulted in this document in which relevant research questions needed to support the deployment of automated road transport across Europe are presented. It is anticipated therefore that this report can guide investment decisions in research so that HF issues are adequately addressed in automated road transport.

8 Annexes

Annex 1 – Face-to-face meetings

Table 2: Face-to-face meeting activities involving HF-related discussion topics

When	Where	Main HF-related topics
2013/03/07	Brussels	Workshop on Automation in Road Transport: To share the progress and recommendations of iMobility Forum with the international transport community.
2013/05/27	Brussels	Negotiation Meeting: To discuss scope, objectives and contribution content on national and international level
2013/07/04	Dublin	ITS Dublin with participation of HF-related project partners
2013/07/13	Washington, D.C.	TRB Annual Meeting with participation of HF-related project partners
2013/09/30	Brussels	VRA Consortium meeting: To define the practical details (calendar, topics, objectives, main contributors, etc.) related to the international TF, concertation meetings and automation WG as well as the organisation of the three discussion groups (responsibilities, calendar of meetings, etc.)
2013/10/01	Brussels	VRA European Concertation meeting: to share information on the projects that are being planned following the Call10 of DG Connect and plan liaison right from the start with a set of shared actions
2013/10/14	Tokyo	ITS Tokyo with participation of HF-related project partners
2014/01/23	Brussels	VRA Consortium Meeting: To share and discuss information on web resources, webinars, current projects and next actions
2014/01/24	Brussels	iMobility Working Group Automation in Road Transport Meeting: To plan and work on the roadmap document for the EC
2014/07/05	Antwerp	VRA – iMobility Automation Working Group Meeting with Open Workshop Automation
2014/06/16	Helsinki	ITS Helsinki with participation of HF-related project partners
2014/07/14	San Francisco	TRB Annual Meeting with participation of HF-related project partners
2014/09/07	Detroit	ITS Detroit with participation of HF-related project partners

2014/09/17	Brussels	Workshop WG Automation: to discuss the recommendations to be provided to the EC for the H2020 calls (2015-2017) by the end of September 2014
2014/09/25	Brussels	Project Development Workshop: To plan and homogenize the future project ideas and applications
2014/11/17	Tokyo	Workshop on Connected and Automated Driving Systems with participation of HF-related project partners
2014/12/01	Lausanne	VRA Meeting: To share Highlights in EU projects on Automated Driving
2014/12/02	Lausanne	Automation Working Group Meeting: To consolidate results and to discuss further steps
2015/04/28	Brussels	Automation Working Group Meeting: To discuss timeline and content of the position whitepaper due in fall 2015
2015/01/11	Washington, D.C.	TRB Annual Meeting with participation of HF-related project partners
2015/06/30	Brussels	Standardization meeting within the EU FP7 Call 10 Projects
2015/07/01	Brussels	VRA – iMobility Automation Working Group Meeting: To report on the past activities, plan, discuss and work on the position white paper
2015/09/22	Brussels	VRA – iMobility Automation Working Group Meeting: To report on the past activities, plan, discuss and work on the position white paper
2015/10/05	Bordeaux	ITS Bordeaux with participation of HF-related project partners

Annex 2 – Phone and web activities

Table 3: Phone and web activities involving HF-related discussion topics

When	Where	Main HF-related topics
2013/09/04	Phone	VRA Administrative Kick-off meeting
2014/02/18	Phone	iMobility Forum Automation WG HF-subgroup phone and web call: To discuss the structure of the HF-related contribution to the roadmap document
2014/02/21	Phone	VRA Management Conference Call: To discuss the current status and further steps on dissemination strategy
2014/03/19	Phone	iMobility Forum Automation WG HF-subgroup phone and web call: To discuss the structure of the HF-related content for the roadmap document
2014/04/06	Phone	iMobility Forum Automation WG phone and web call: To share the current status of the HF-subgroup and to plan further steps
2014/05/21	Phone	Planning of the iMobility Forum Automation WG HF-subgroup contribution for TRB 2015
2014/06/06	Phone	VRA Management Conference Call: To discuss the current status and further steps on dissemination strategy and activities related to the trilateral meetings
2014/09/01	Phone	VRA Management Conference Call: To plan the next VRA activities as well as webinars etc.
2014/09/09	Phone	iMobility Forum Automation WG phone and web call: To plan the last steps and the content of the HF-related '2-pager' for the EC
2014/09/26	Phone	VRA Management Conference Call: To plan the next high level events related to HF content as well
2014/09/30	Phone	VRA WP3 Restructuring Phone Conference
2014/10/10	Phone	VRA Management Conference Call: To plan the next VRA activities as well as webinars etc.
2014/10/30	Phone	VRA Management Conference Call: To plan the next VRA and Automation WG activities
2014/11/27	Phone	VRA Management Conference Call: To plan the next VRA and Automation WG activities
2014/12/19	Phone	VRA Management Conference Call: To plan the next VRA and Automation WG activities, such as preparation of ITS World

		Congress in Bordeaux
2015/05/29	Phone	VRA Management Conference Call: To plan the next VRA and Automation WG activities
2015/06/18	Phone	VRA Task Leaders Conference: To plan the restructuring of WP3 and the new Deliverables
2015/08/11	Phone	iMobility Forum Automation WG phone and web call: To share the current status of the HF-subgroup and to plan content for the HF-related position white paper content

Annex 3 – Trilateral meetings

Table 4: Trilateral activities involving HF-related discussion topics

When	Where	Main HF-related topics
2013/07/19	Washington, D.C.	Trilateral meeting: To discuss and clarify our understanding of each region's plans and to consider the types of cooperation and structure for shared work
2014/05/07	Antwerp	Trilateral meeting with Open workshop Automation
2014/07/15	San Francisco	Trilateral meeting: To share and discuss Status of activities in each of the six cooperation areas
2014/12/02	Lausanne	Trilateral meeting: To share and discuss Status of activities in each of the six cooperation areas

9 Sources

[1] SAE document J3016, “Taxonomy and Definitions for Terms Related to On-Road Automated Motor Vehicles”, issued 2014-01-16, see also http://standards.sae.org/j3016_201401

[2] EU-VRA-Community (2015): VRA network in automation. http://vra-net.eu/. Last access on 05.11.2015