Submitted by the expert from IEA
(For review during the Troy meeting, 20-24 May 2024)

Informal document **GRVA-19-39**
19th GRVA, 25 June 2024
Agenda item 4(i)

Requirements for Safe in-Vehicle Interaction with Driving Automation Systems

(Informal paper GRVA-19-10)

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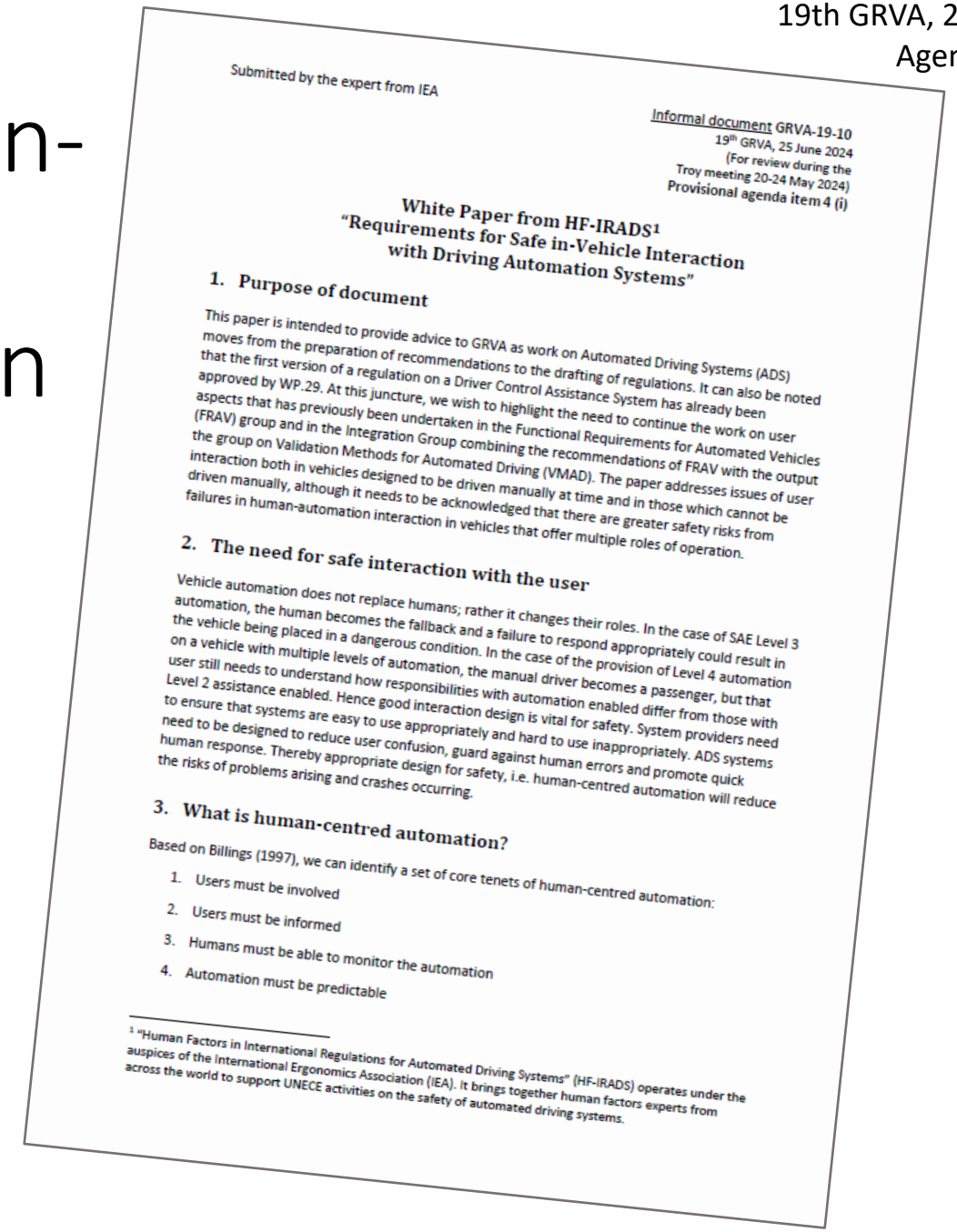

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Provisional agenda item 4 (i)

White Paper from HF-IRADS[1]
"Requirements for Safe in-Vehicle Interaction with Driving Automation Systems"

1. Purpose of document

This paper is intended to provide advice to GRVA as work on Automated Driving Systems (ADS) moves from the preparation of recommendations to the drafting of regulations. It can also be noted that the first version of a regulation on a Driver Control Assistance System has already been approved by WP.29. At this juncture, we wish to highlight the need to continue the work on user aspects that has previously been undertaken in the Functional Requirements for Automated Vehicles (FRAV) group and in the Integration Group combining the recommendations of FRAV with the output the group on Validation Methods for Automated Driving (VMAD). The paper addresses issues of user interaction both in vehicles designed to be driven manually at time and in those which cannot be driven manually, although it needs to be acknowledged that there are greater safety risks from failures in human-automation interaction in vehicles that offer multiple roles of operation.

2. The need for safe interaction with the user

Vehicle automation does not replace humans; rather it changes their roles. In the case of SAE Level 3 automation, the human becomes the fallback and a failure to respond appropriately could result in the vehicle being placed in a dangerous condition. In the case of the provision of Level 4 automation on a vehicle with multiple levels of automation, the manual driver becomes a passenger, but that user still needs to understand how responsibilities with automation enabled differ from those with Level 2 assistance enabled. Hence good interaction design is vital for safety. System providers need to ensure that systems are easy to use appropriately and hard to use inappropriately. ADS systems need to be designed to reduce user confusion, guard against human errors and promote quick human response. Thereby appropriate design for safety, i.e. human-centred automation will reduce the risks of problems arising and crashes occurring.

3. What is human-centred automation?

Based on Billings (1997), we can identify a set of core tenets of human-centred automation:

1. Users must be involved
2. Users must be informed
3. Humans must be able to monitor the automation
4. Automation must be predictable

[1] "Human Factors in International Regulations for Automated Driving Systems" (HF-IRADS) operates under the auspices of the International Ergonomics Association (IEA). It brings together human factors experts from across the world to support UNECE activities on the safety of automated driving systems.

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The need for safe interaction with the user

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- Appropriate design for safety, i.e. human-centred automation, will reduce the risks of problems arising and crashes occurring

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4. Automation must be predictable
5. Automation must monitor the human (input/state)
6. Intent must be dually communicated between automation and human

How do we ensure safe interaction between vehicle and user?

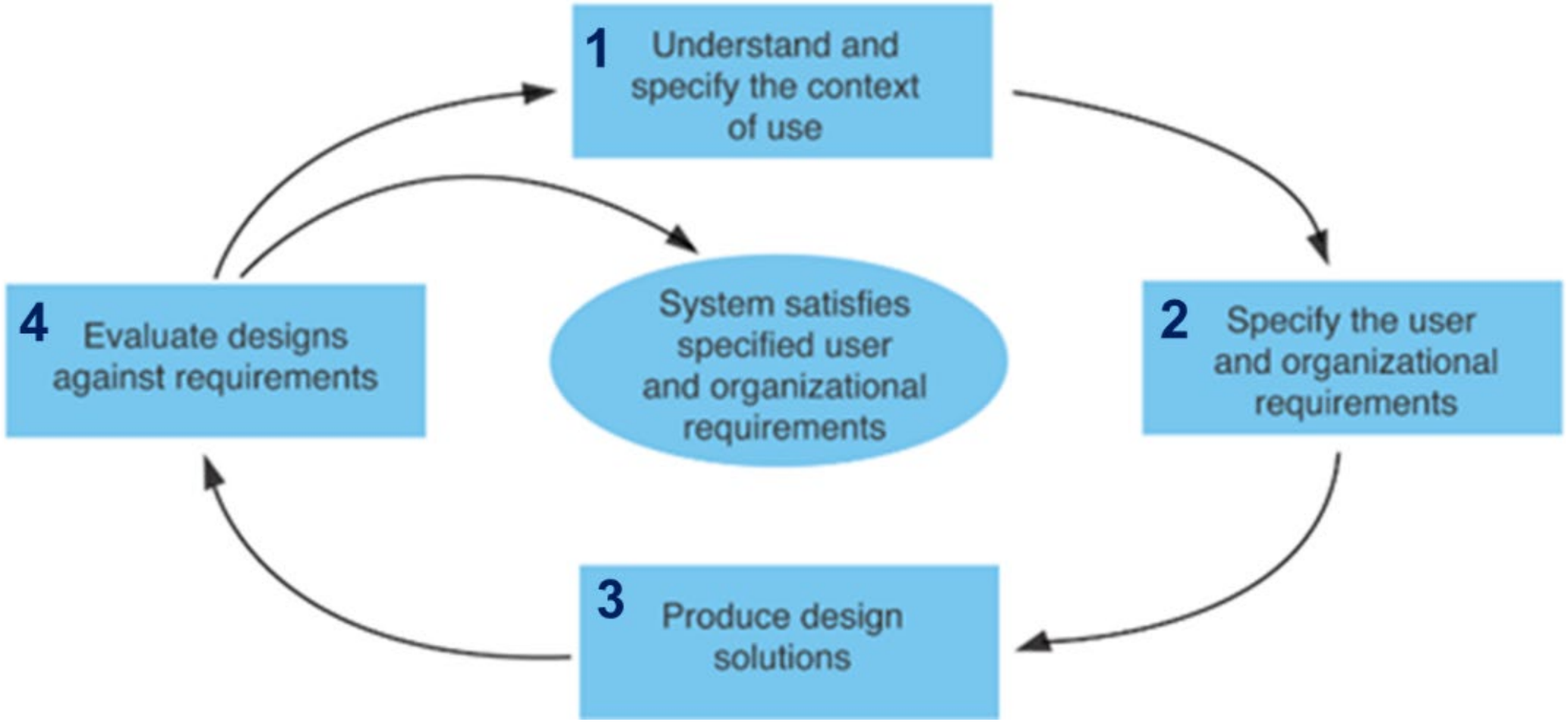
- Both intended use of systems and anticipated intentional and unintentional misuse must be considered. Therefore, there is a need to support user understanding for intended uses and perform a detailed safety analysis to address anticipatable misuse.
- Interaction design needs to address user understanding of changeable user roles, mode structure and interactions in, for example, enabling the Automated Driving System (ADS) and responding to requests to intervene.
- System limitations must be clearly communicated to drivers
- Robust mechanisms for monitoring and engaging drivers are necessary to mitigate foreseeable risks of complacency and inattentiveness.

Human-Centred Design

ISO 9241-210:2019 describes 6 principles to be followed to ensure the design is Human-Centred:

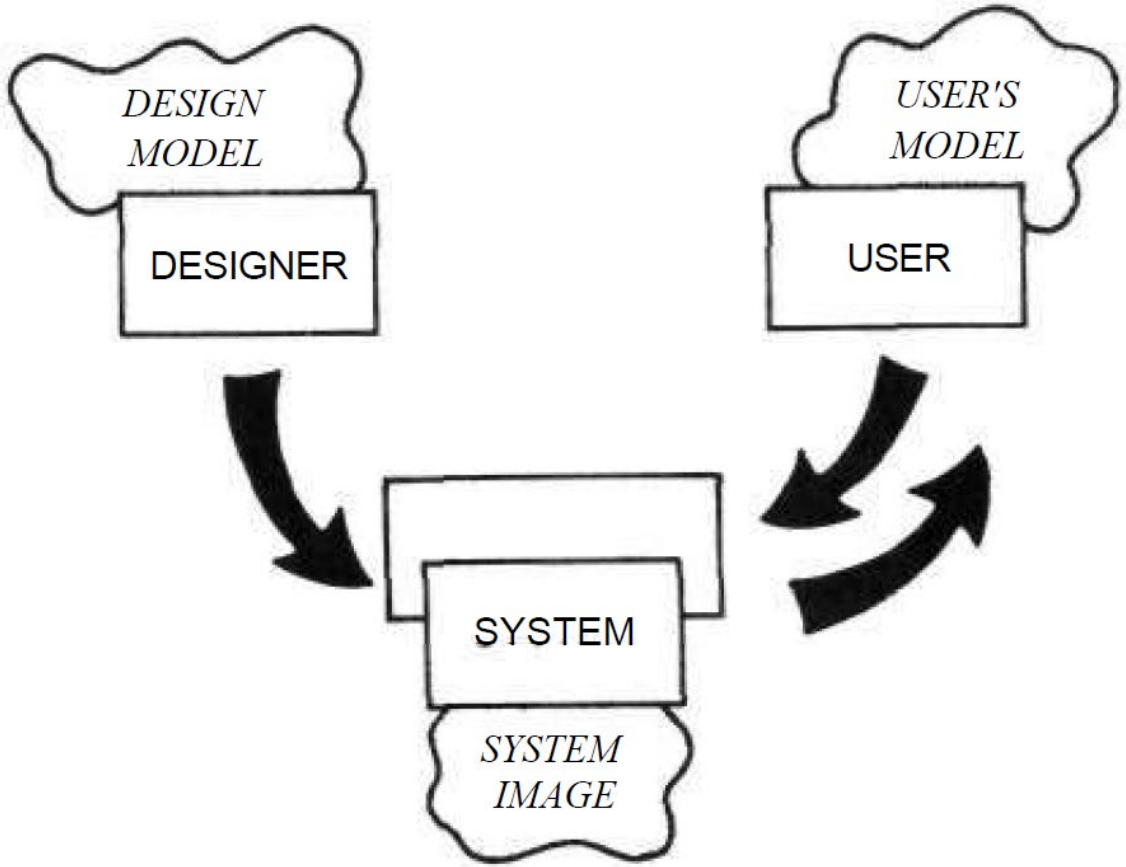
1. The design is based upon an explicit understanding of users, tasks and environments
2. Users are involved throughout the design and development process
3. The design is driven and refined by user-centred evaluation
4. The process is iterative
5. The design addresses the whole user experience, including emotional aspects
6. The design team includes multidisciplinary skills and perspectives, including expertise in human factors

Iterative process of Human Centred Design



Also

- Support role awareness
- Mitigate against mode confusion
- Enhance easy acquisition of appropriate mental models, i.e. ones where the mental models of designers and users coincide
- Test with diverse users



Mental models (Norman, 1988)

Recommendations to GRVA

1. Interaction safety must be set as an objective and integrated in the safety case for a DAS since it is mission-critical.
2. The use of the Human-Centred Design process with the involvement of the expected range of users in the different stages of the development of driving automation systems must be verified.
3. There is a need to develop verifiable requirements on interaction, including on driver monitoring.
4. The Human-Centred Design process and established HMI principles be applied to create a high-level commonality of interaction design across vehicles and levels of automation. This will assist users in easy adaption to new vehicles and in switching from one vehicle to another in their daily use.

Recommendations to GRVA (2)

5. The consequent design recommendations could then be applied in feature development and be used in checklists at the verification or approval stage, which would substantially reduce development costs.
6. It will be Important to draw lessons from post-production In-Service Monitoring and Reporting to inform recalls and the refinement of driving automation system safety. Any substantive changes to interaction with driving automation systems, such as through over-the-air updates, require verification and notification of the changes to drivers.
7. Above all, we need an integrated approach that spans automation across the different SAE levels of automation in order to accommodate safe user interaction with these levels on a single vehicle.

Thank you for your attention!

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