Autonomous Vehicles:
A Human Factors Perspective

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Some Key HF Questions

- How will we…

    – Divide responsibilities?
    – Enable safe automation transitions?
    – Manage interactions?
    – Ensure public acceptance?

Divide responsibilities

- Support, don't replace, the driver.
  - People:
    high level goals, patterns, the unexpected
  - Automation:
    repetition, accuracy, precision, vigilance
- Design for teamwork/cooperation

HUMAN ENGINEERING FOR AN EFFECTIVE AIR-NAVIGATION AND TRAFFIC-CONTROL SYSTEM

by

Paul M. Fitts (Editor)

3964

Humans appear to surpass present-day machines in respect to the following:

1. Ability to detect small amount of visual or acoustic energy.

2. Ability to perceive patterns of light or sound.

3. Ability to improvise and use flexible procedures.

4. Ability to store very large amounts of information for long periods and to recall relevant facts at the appropriate time.

5. Ability to reason inductively.

6. Ability to exercise judgment.

Present-day machines appear to surpass humans in respect to the following:

1. Ability to respond quickly to control signals, and to apply great force smoothly and precisely.

2. Ability to perform repetitive, routine tasks.

3. Ability to store information briefly and then to erase it completely.

4. Ability to reason deductively, including computational ability.

5. Ability to handle highly complex operations, i.e. to do many different things at once.

March 14, 1951

Enable safe automation transitions

- Driving an AV is a *supervisory* task.

- When automation fails, operator needs to
  - Regain attention, diagnose, act
  - (Possibly with little or no warning)

- The better automation gets, the less we monitor
  - Problem even for highly motivated, trained professionals

- Need to confirm driver responded in a safe manner

Manage interactions

- **Keep stakeholders informed**
  ... And in the loop
- **Keep them trained**
  - Maintain skills
- **Includes:**
  - The driver/operator
  - Other drivers
  - Vulnerable road users

Are you going? Or should I go?

You go first.

What if I point a lot and flail my arms around?

This is confusing.

Wait, maybe you should go.

Let's just sit here and reflect.

Encourage acceptance

- Will people accept reduced manual control
  - at closer following distances?
  - on narrower lanes?
  - at higher speeds?
- "Calibrate" operator trust
- Don't overpromise

Summary of Levels of Driving Automation for On-Road Vehicles

This table summarizes SAE International's levels of *driving* automation for on-road vehicles. Information Report J3016 provides full definitions for these levels and for the italicized terms used therein. The levels are descriptive rather than normative and technical rather than legal. Elements indicate minimum rather than maximum capabilities for each level. "System" refers to the driver assistance system, combination of driver assistance systems, or *automated driving system*, as appropriate.

The table also shows how SAE's levels definitively correspond to those developed by the Germany Federal Highway Research Institute (BASt) and approximately correspond to those described by the US National Highway Traffic Safety Administration (NHTSA) in its "Preliminary Statement of Policy Concerning Automated Vehicles" of May 30, 2013.

Level	Name	Narrative definition	Execution of steering and acceleration/ deceleration	Monitoring of driving environment	Fallback performance of *dynamic driving task*	System capability (*driving modes*)	BASt level	NHTSA level
Human driver monitors the driving environment								
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a	Driver only	0
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes	Assisted	1
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes	Partially automated	2
Automated driving system ("system") monitors the driving environment								
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task* with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes	Highly automated	3
4	High Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes	Fully automated	3/4
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**	-	

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Irony of Automation

"The more advanced a system is, the more crucial may be the contribution of the human operator"

Lisaine Bainbridge (1983)

Questions?

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