Safety Through Automation Program

National Highway Traffic Safety Administration

Office of Vehicle Crash Avoidance and Electronic Controls Research, NVS-330
Electronic Systems Safety Division

US Department of Transportation
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Major Goals

Improve motor vehicle safety by defining the requirements for automation assisted driving that is:

• Functionally safe and electronically reliable.
• Secure from malicious external control and tampering.
• Precise in vehicle steering, braking, and acceleration.
• Compatible with driver abilities and expectations.
  • Operationally intuitive for drivers under diverse driving conditions.
  • Supportive of improving driver awareness in traffic.
  • Operational only to the extent granted by the driver.
• Highlights the potential benefits of vehicle automation.

• Describes NHTSA’s safety role on automation and the levels of automation that NHTSA uses for ease of discussion and analysis.

• Explains our research plan for automated vehicles.

• Offers recommendations for states that are developing laws related to self-driving vehicles - pertaining only to levels 3 and 4 automation.
Motor Vehicle Automation Research Roadmap

**Efforts**

1. Early Policy Exploration
   - Complete human factors studies to evaluate emerging concepts
2. Program Planning/ Knowledge Base
   - Perform literature reviews, hold workshops and research critical issues
   - Synthesize findings into a program plan
3. Develop System Performance Requirements
   - Performance requirements for automation levels and associated system concepts
4. Address Electronic Control Systems Safety
   - Reliability and Cybersecurity requirements
5. Improve Driver Awareness & Response
   - Display & control interface criteria and guidelines
   - Driver Training & Licensing requirements
6. Evaluate System Operability
   - Develop objective tests
   - Define safety metrics
   - Complete Evaluation studies
   - Estimate Benefits

Pre-decisional
Automation Issues Influencing Research Plan

• Human Factors Issues:
  – Ensuring safe shared vehicle control between the driver and automated driving modes.
  – Driver-vehicle interface requirements, licensing requirements.

• Technical and Regulatory Requirements:
  – Defining technical requirements/performance criteria for various levels of automation.
  – Requirements for potential safety standards.

• Electronic Control Systems Safety and Cybersecurity

• Test and Evaluation challenges – how to comprehensively test automated systems

• Operating environment – Assuming operation in mixed traffic and on public roads
  – Identify and evaluate operating scenarios / use cases.
Vehicle Automation Research Framework

Automation Level

- **L4**: Driver Sets Broad Goals (navigation input), robot has full control authority and responsibility
- **L3**: Driver can cede authority under certain conditions and is not expected to be constantly engaged
- **L2**: Driver shares control authority but driver expected to be constantly engaged (e.g., LC with ACC)
- **L1**: Driver has overall authority and solely responsible for safe operation (ESC, CIB)
- **L0**: No Automation/Manual driving (FCW, LDW)

Technology Integrity

- Adaptability
- Operability
- Availability
- Cyber Security
- Reliability

Driver-Vehicle Interface

- Information Acquisition
- Information Analysis
- Decision Selection
- Action Implementation
- Driver Performance

Driver Performance

Operating Environment

- Roadway
- Traffic
- Environment

Driver Cond.
Conceptual Framework - Levels of Automated Driving

Level 0: No Automation
- No steering or braking/throttle control.
- e.g., crash warning systems, including V2V applications.

Level 1: Function Specific Automation
- Braking/throttle and/or steering control, but not designed to work in combination to enable hands free/foot off pedal operation.
- e.g., automatic braking systems, lane keeping systems.

Level 2: Combined Function Automation
- Integration of braking, throttle, and steering control designed to enable “hands free/foot off pedal operation”.
- Driver available at all times to retake control.

Level 3: Limited Self Driving Automation
- Integration of braking, throttle, and steering control.
- Driver expected for occasional control.
- Driver can cede full monitoring and control authority.

Level 4: Full Self Driving Automation
- Integration of braking, throttle and steering control.
- Driver NOT expected for control.
- Responsibility for safe operation is solely rests with the vehicle.

Pre-decisional
NHTSA’s Research Plan - Progress

• Significant agency focus on Level 0 and Level 1 systems
  – Level 0 – radar, camera, and/or V2V enabled crash warnings.
  – Level 1 – radar, camera, potentially enhanced by V2V, to provide level 0 capability plus single function automation (e.g. automatic braking).
  – Significant safety benefit potential.
  – Rulemaking decisions upcoming.

• Initiating research on Levels 2-4
  – Within the last year, significant information gathered on automated vehicle research.
  – NHTSA has developed an initial research approach.
  – Working cooperatively with other DOT agencies to initiate research.
NHTSA’s Research Plan – Focus Areas for Highly Automated Vehicles (Levels 2-4)

• Human Factors Research
  – Initial research started to evaluate key issues.
  – Will inform policy decisions and develop initial Driver-Vehicle Interface (DVI) recommendations.

• Electronic Control Systems Safety
  – Research focus on ensuring the safety of complex electronic control systems and cybersecurity.

• System Performance Requirements
  – Evaluate key operational use cases and constraints.
  – Develop test and evaluation methods.
  – Develop basic performance tests/criteria.
Safety Guidance to States: Recommendations for Level 3 and Level 4 Automation

I. Licensing Drivers to Operate Self-Driving Vehicles for Testing.

II. Recommendations for State Regulations Governing Testing of Self Driving Vehicles.

III. Basic Principles for Testing Self Driving Vehicles.

IV. Regulations Governing the Operation of Self Driving Vehicles for Purposes Other Than Testing.
Projects

NHTSA and FHWA ITS/JPO Collaboration
Federal Highway Administration
Intelligent Technology Systems Joint Programs Office, HOIT-1
Connected Vehicle Safety & Automation Division

Project 1: Human Factors Evaluation of Level 2 and Level 3 Automated Driving Concepts

October 2012 – December 2014
Human Factors Evaluation of Level 2 and Level 3 Automated Driving Concepts

Project Process

Use Case Scenarios

- HF Guidelines Input
- Stakeholder Panel
- HF Academic Roundtable
- Design Best Practices
- Emerging Systems
- Automation Concepts Primer
- Data Mining Study

Research Questions

Guidelines & Reqt's

Experiments

Pre-decisional
Human Factors Evaluation of Level 2 and Level 3 Automated Driving Concepts

Key Research Questions

1. Can drivers safely interact with and operate vehicles that offer automation Level 2 and Level 3 systems, e.g. what is the driver performance profile over length of time in continuous or sustained automation?

2. What are the system performance risks from driver involvement with and interruption from secondary tasks (such as portable electronic device use) that could arise when operating Level 2 or Level 3 automated vehicle system?

3. What are the most effective hand-off strategies between the system and the drive including response to faults/failures?

4. How do drivers engage, disengage, and reengage with the driving task in response to the various states of Level 2 and Level 3 automation?

5. How do drivers perform under various operational concepts within Level 2 and Level 3 automation, such as systems intended for everyday driving on open roadways in mixed traffic or systems intended for dedicated roadway-vehicle applications (e.g. automated lanes, remote highways)?

6. What are the most effective human-machine interface concepts, guided by human factors best practices, which optimize safe operation of Level 2 and Level 3 systems?
QUESTIONS?