PERFORMANCE OF HETEROGENEOUS TRAFFIC – WHAT CAN WE EXPECT?

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SYMPOSIUM DRIVING THE INTELLIGENT VEHICLE
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Contents

- Transition to automated vehicles / ITS
- Traffic flow effects
  - What could happen?
  - How can we assess this
- **Focus on motorway traffic**

Transition through automation levels

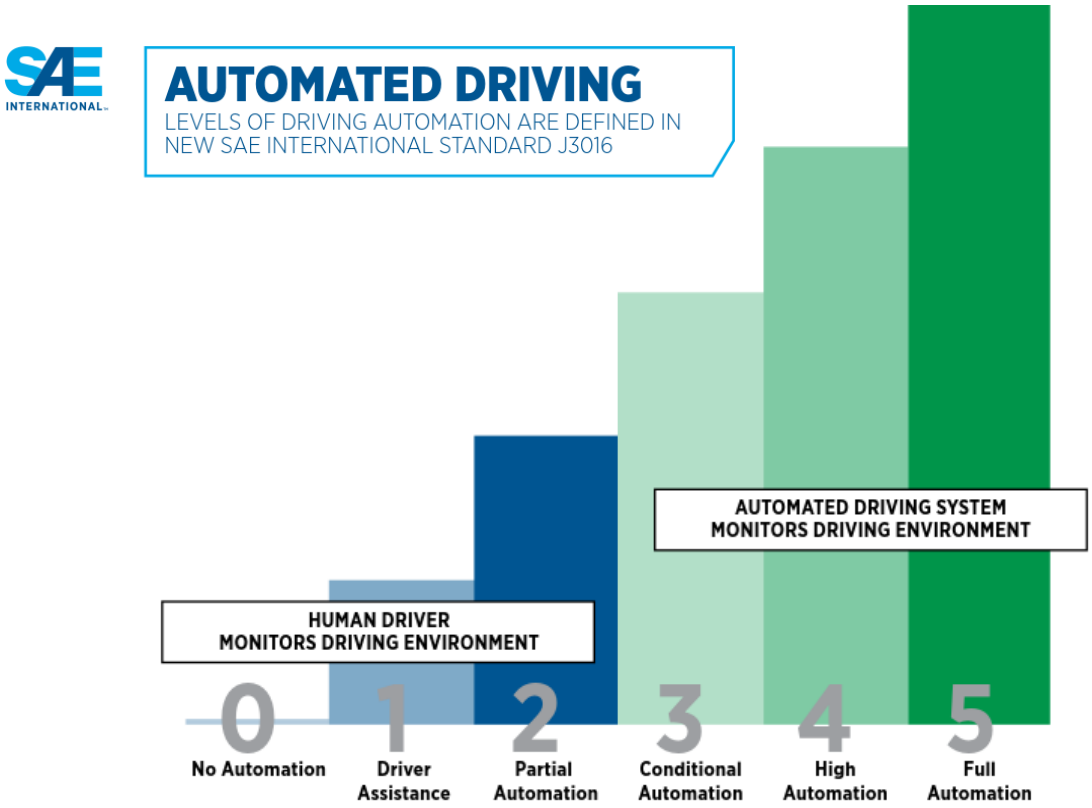
- Hot topic world wide
- High expectations

- Challenges
  - Privacy/Data
  - Security
  - Liability

assume these will all be tackled

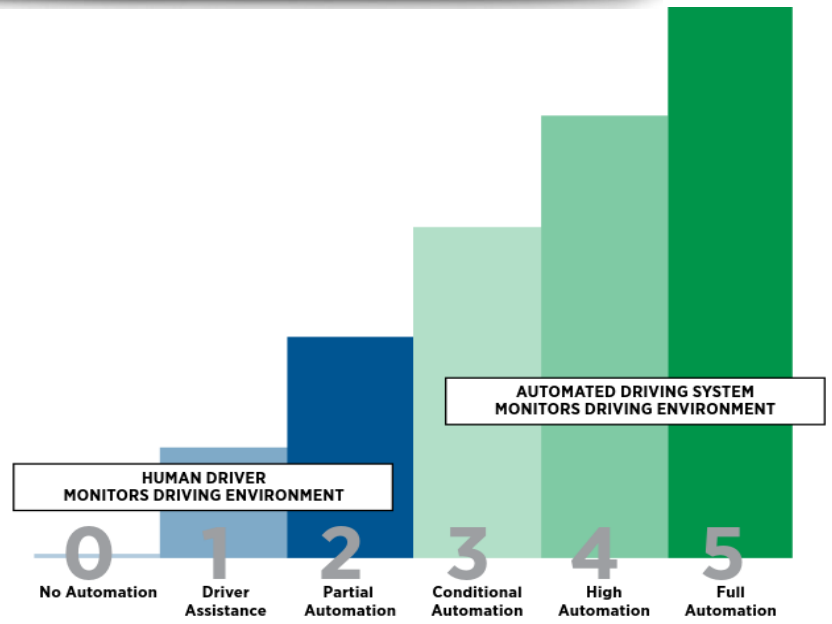
- End situation
  - *Some* driverless cars
  - *Many* driverless cars?
  - *All* cars driverless?

- When?



Mobility with autonomous vehicles

- Fact of life
- Blessing or disaster?
- Societal reaction, adoption
- Government responsibility
- Eventually driving your own car will only be for leisure
- In transition years we will see heterogenous traffic



Traffic on motorways

Increasing
- vehicle automation

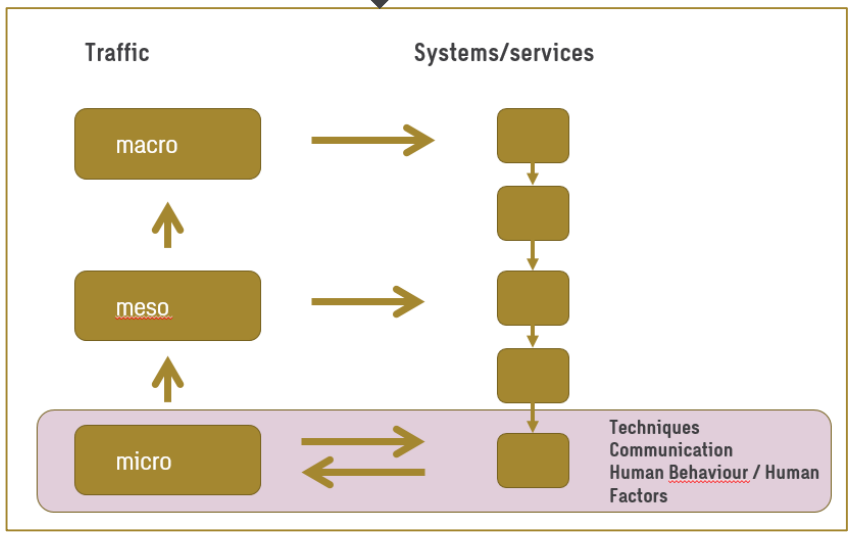
enhanced with
- co-operative functions

Different vehicles, different automation levels
→increasing diversity

→Efficiency gain for intense traffic, peak hours
→How?

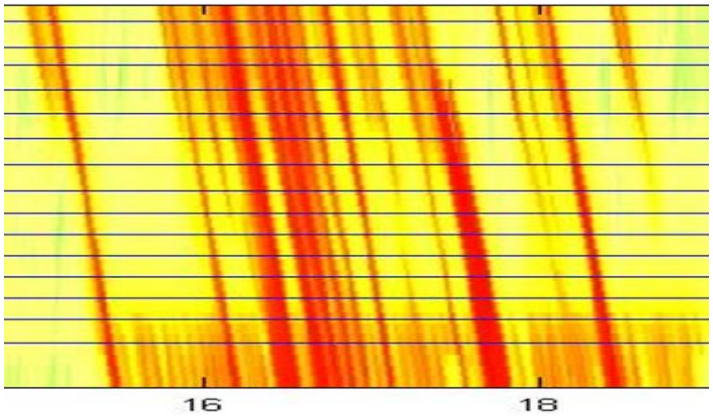
Automation
- Cruise control (CC), Adaptive cruise control (ACC)
- Co-operative Adaptive Cruise Control (CACC)
- Lane keeping
- Autopilot
- …

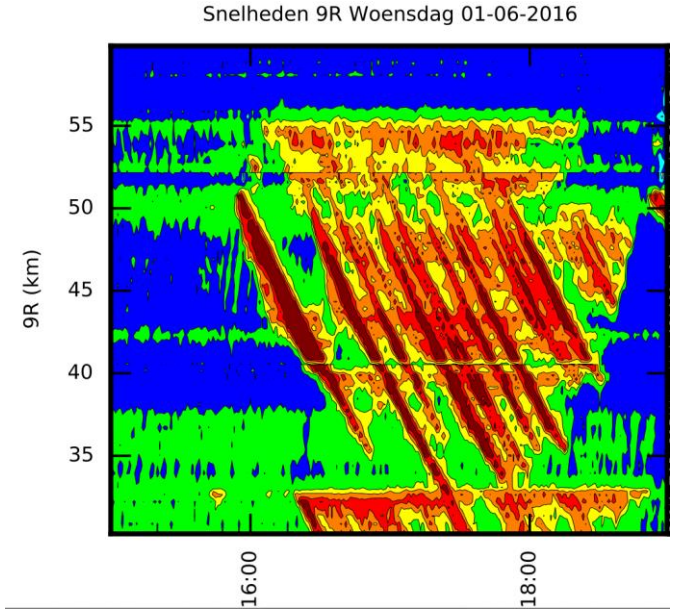
Human driver support systems
- Alerts
  - speed
  - Line of driving
- Advice
  - speed (e.g. shock wave-app)
  - Lane choice
  - Green waves (GLOSA)
  - …



Example of field test: shock wave traffic jams

- Advices to drivers:
  - Speed
  - Headway/gap
  - Lane



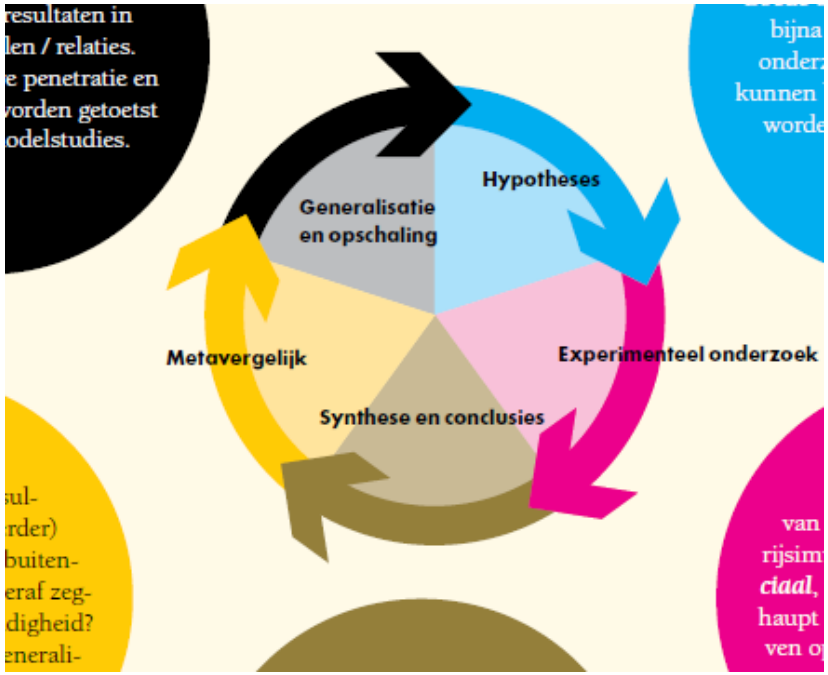


services result in
- less
- narrower
- shorter

shock waves

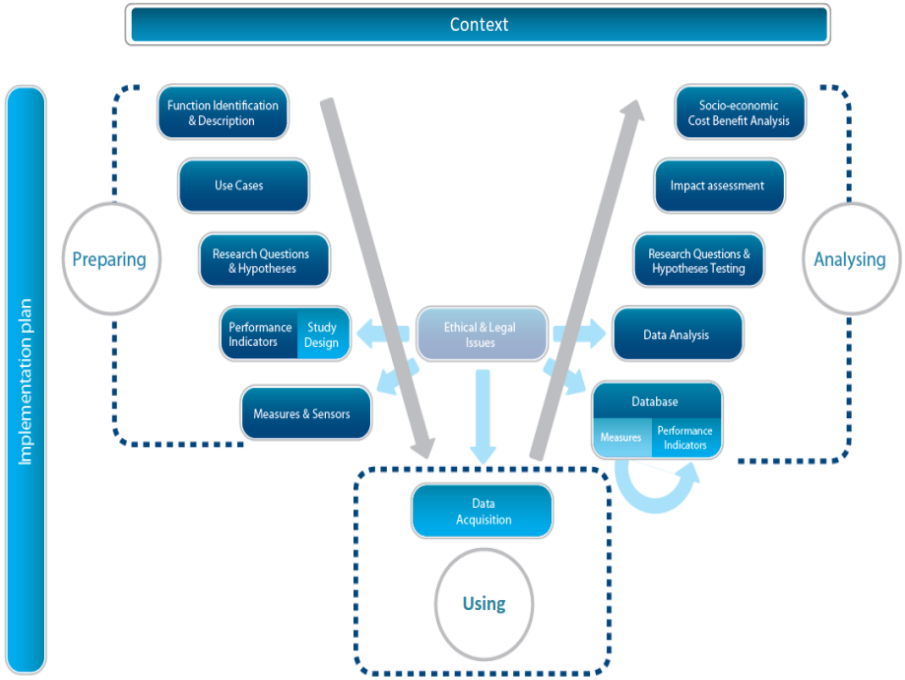
Research: Methodological framework

Evaluation circle



Hans van Lint, TUD, o.a. NM Magazine 2016 #2

FESTA V-model



FESTA Handbook v5: http://wiki.fot-net.eu/index.php/FESTA_Handbook, 2014

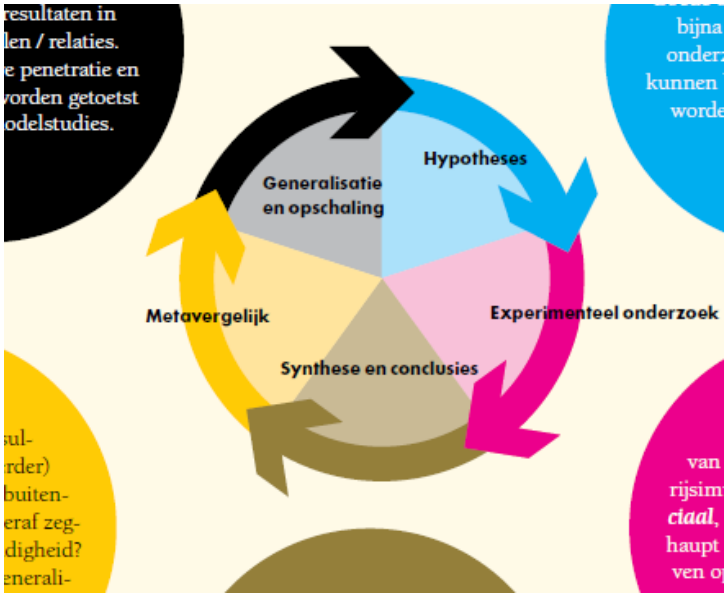
Effect measurements

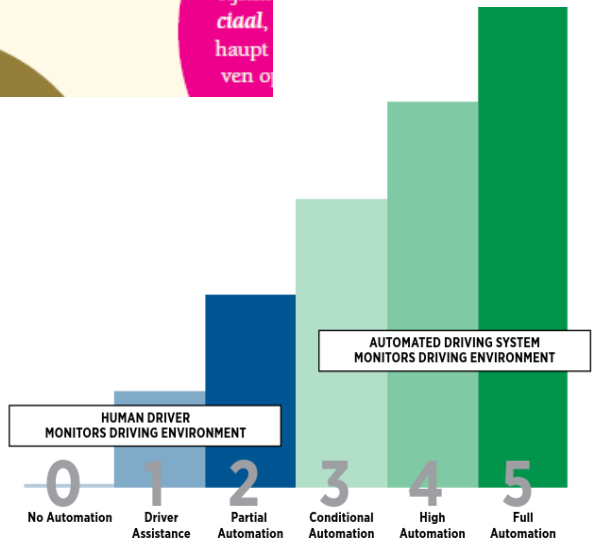
- Traditionally:
  - before period
  - after period
  - both stationary

Now:

- Penetration level
  - Transition period:
    - Multiple penetration levels
    - Continuously changing

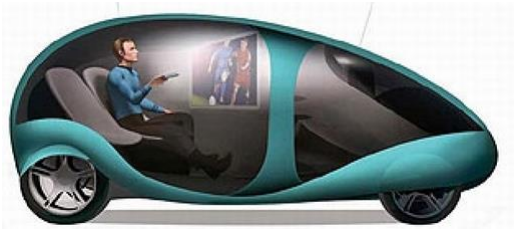
→Challenge for researchers





Heterogeneous traffic

- Changing penetration levels



Increasing number of ‘alien’ vehicles

- ‘Different‘ behaviour, dynamics
  - Recognisable for ‘normal’ drivers?
  - How will these react?

- Driverless cars initially behave as beginners?

- Eventually manual drivers will be the aliens, causing traffic flow perturbations

Traffic characteristics

- **Speed and car following behaviour**
  - Co-operative systems are potentially better than human drivers
  - Trains/platoons of vehicles
    - Manual driver in between sees a very long vehicle
    - Length? Persistence?
    - Effective overall road capacity?
- **Lane change behaviour**: still needed? possible? desirable?
- Dragging along
- segregation (by lanes): spontaneously, regulated, stimulated, enforced?

Indicators for motorway traffic: changing signification

- Short headways
  - Throughput
  - Comfort?
  - Dangerous (if manual driver)
- Larger gaps
  - Throughput
  - Some are needed to annihilate shock waves
- Lane changes
  - Disturbances
  - Efficient for filling gaps
- Speed differences
  - Today considered dangerous, but ...

Eventualle everything potentially changes:

- Headway and gap distributions
- Speeds
- Capacity
- Fundamental diagram

Analysis and measurements – a challenge

- Indicators?
  - Platoon
  - Off-platoon
  - Cross-platoon

- Data collection?
  - Advanced vehicles!
  - Other vehicles?
  - Interaction?

Traffic between junctions – can we expect the following?

- **All automated**:
  - Smaller gaps *possible*
  - Smaller gaps will do for damping disturbances

- **Mix of manual and automated vehicles:**
  - Disturbances
  - Underperformance
  - Even less efficient than fully manual traffic

- Imagine segregation: e.g.
  - **Left lane:** many co-operative platoons
  - **Middle lane:** intermediate categories, like
    - Autonomous *but not co-operative* vehicles
    - Vehicles with normal ACC, etc.
  - **Right lane:** manual drivers

  Better for everyone and more comfortable
  Will this happen spontaneously, regulated, stimulated, enforced?

What to expect for road infrastructure planning?

Not feasible: dedicated system, lanes, roads for full automated driving
- Space consuming
- Expensive
- We are too late

Be prepared for:

- *Between junctions*: ever more efficient, capacity increases → allowing/producing more traffic
- Around junctions, cities: *extra road space needed*, as efficiency gain is much less there

If needed, extra services/facilities for:

- Segregation
- Communication (4G, 5G, Wifi-p)

Thanks for your attention! Questions?

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