Autonomy in Transport

Areas of interest and research questions

The following notes are divided into the four major themes of

1. Societal and Ethical issues
2. Computing
3. Human Factors
4. Engineering

Each section then contains a number of issues and areas of interest as well as associated research questions, that emerged from the discussions throughout the event.

1. Societal and Ethical issues

- Responsibility
  - Who is to blame when things go wrong? (i.e. car manufacturer, programmer, owner of the autonomous vehicle, “driver”)
    - The role of the programmer seemed to be a particularly contentious point
  - Do autonomous systems have the responsibility to report illegal activity when it is detected? (i.e. recent case when an emergency system in a car detected a crash and alerted the local authorities, leading to the identification of a hit-and-run driver)
- Redundancy
  - What happens when something goes wrong?
- State involvement
  - Should the taxpayer subsidise car manufacturing? (i.e. to accelerate the move to autonomous vehicles?)
  - What role will street lighting play now once lower levels of lighting are required for autonomous vehicles?
- Regulatory regime
  - How do you legislate who to run over?
    - Who decides for the least damage choices in case of an imminent collision?
  - How do you regulate autonomous vehicles and the surrounding ecosystem effectively?

    - Who gets access to camera footage from autonomous vehicles?
    - How do you identify who sat in the car?
    - How do you give consent to an autonomous vehicle?
- Public perception
    - How can we counteract public perceptions of job losses?
    - How can we increase trust into autonomous vehicles?
    - Will these vehicles be perceived as safe?
        - By whom?
        - What is the meaning of safe?
    - Should autonomous be obvious? (i.e. google glass vs. the DLR)
    - What role does the media play in the introduction and adoption of autonomous vehicles and technologies?
        - How do we manage advanced daily mail scares?
    - What role do human health issues play?
- Ownership
    - What ownership models will be appropriate for a future with autonomous vehicles?
        - Will we want to subscribe to fleets of cars or will we want personal devices each?
        - What affects or regulates this?
    - Will drivers own their vehicles or are they merely “safekeepers”?
    - Should we have a fleet of taxis or car clubs for young drivers or users without current car ownership?
    - How do we mitigate cost of autonomous vehicles? (i.e. will they just be for the richer parts of society or can we subsidise autonomous vehicles for the masses?)
    - Will the swapping and selling-on of cars be possible?
- Manufacturers
    - Will car manufacturers move from being hardware to software companies?
        - Will mobility become a service?
    - How do we help airlines achieve their goals within the whole system?
- Investment
    - Should we be investing in autonomous cars or are there better benefits in investing in autonomous trans and buses?
- Survival of the fittest

- What is the role of the pedestrian in a future with increasing automation?
- How do we deal with job losses through automation?

- Benefits and transport economics
  - Should we strive for full automation or increased autonomy?
  - What are the benefits of autonomous vehicles?
    - Are the benefits of autonomous vehicles worth it?
  - Are the increased costs for the introduction of autonomous vehicles work the added value (i.e. time, efficiency)?
    - Who pays?
    - Who benefits?
  - Autonomous vehicles give us more time to do what?
- Land-use
  - Will autonomous vehicles detect faults in the underlying infrastructure (i.e. potholes) and if so, who will it notify?
  - Where is parking? Or will it be cheaper to just drive around instead of paying for parking charges?

2. Computing (Data, UC, Cloud Infrastructure, Personal Infrastructure)

- Systems security
  - How hackable are autonomous systems?
  - How do we deal with issues such as hacking, jamming, spoofing and other illegal activities?
  - Should autonomous vehicles come with a black box?
- (Personal) data
  - What data is available and where?
  - Are autonomous vehicles/ systems purely about stealing your data?
  - What about the lifelong data footprint of an individual (i.e. mistakes in the past that affect future options and choices)
  - Are autonomous vehicles all just about stealing your data?
- Communication infrastructure
  - What communication technologies are required?
  - What bandwidth is required for different systems to operate reliably?
  - How much of the data should be stored in the cloud vs. local storage?
    - How much of the required analysis can be undertaken on the ground
- Situational and context awareness
  - How can we ensure sufficient awareness of others? (i.e. not slamming the brakes if someone will read end your vehicle)
  - Will the autonomous vehicle be able to accurately and reliably assess human behaviour in its path?
  - How will state matching work?
  - How will autonomous vehicles deal with changing road conditions? (i.e. icy roads)
    - What do autonomous vehicles need to know to operate?
- Routing
  - How do we reroute in case of traffic or an accident?
  - Will the “system” be able to balance out the cumulative load of cars in order to prevent congestion?
- Vision and image recognition

    - We need to be able to reliably identify non-humans! (i.e. make the autonomous vehicle choose to run over the cat rather than the human in case of an imminent collision)
    - Detecting and predicting cyclists is very difficult!
- Accuracy
    - Will autonomous vehicles be able to navigate a country-lane where bushes are in the way?
    - Can we reliably fuse the info from all of the different sensors? (i.e. Terry Moore's presentation)
    - How do ensure a sufficient level of fault tolerance?
        - What is a sufficient level of fault tolerance?
        - How do we deal with interference?
- Integration
    - How can we ensure a functional systems integration if multiple manufacturers are involved in the making?
    - How do autonomous vehicles interoperate with other non-autonomous vehicles sharing the same space? (i.e. road)
- Redundancy
    - What happens when something goes wrong?

3. Human factors (perceptions of risk, trust, distraction)

- Responsibility
  - Who do you sue in case of an issue?
  - What impact will missed software updates have on responsibility?
  - Who pays for the connectivity charges?
- Individual perception
  - What personality do cars have? (i.e. aggressive)
  - What is it about the enjoyment of driving?
  - At what stage of automation do we lose control of driving?
    - Is that loss necessarily a bad thing?
- Control
  - How would we deal with unmanned autonomous vehicles in controlled airspace?
    - What role will air traffic control play?
  - What is the best way to hand over between humans and vehicle control? (i.e. regular driving vs. emergency situations)
  - How do we interact with the car? (i.e. through natural language processing)
  - Who is responsible for conveying information?
  - How do we pay for services such as parking and tolls?
- Redundancy
  - What happens when something goes wrong?
- Understanding
  - Will autonomous systems become to complex for us to loose track of how everything is working?
  - How do we keep the human in the loop?
    - How can we still keep drivers engaged so that they are ready to respond in case of an issue or emergency?
- Certification and licensing
  - Is the traditional driving license model outdated?
  - Are we still operators or have we now become monitors?
- Malicious intent/ systems security
  - How do we communicate issues and errors effectively?

4. Engineering (the physical infrastructure needed to ensure autonomy)

- Connectivity
  - How do we ensure adequate signal coverage and signal robustness in remote areas?
  - What role do vehicular ad hoc networks play in ensuring adequate signal coverage and robustness?
  - How do we facilitate safe interaction between autonomous and non-autonomous vehicles that are sharing the same space?
  - What is a sufficient level of reliability, robustness and integrity?
    - What connectivity volume is required?
  - GNSS alone has weak signal strength and accuracy in urban areas
- Computing
  - We need low-power embedded computing that is capable of dealing with large amounts of data input!
- Accuracy
  - Will autonomous vehicles be able to navigate a country-lane where bushes are in the way?
  - Do we have to the required sensor input technologies available yet?
  - How do we ensure fault tolerance?
  - How do we maintain sensors?
    - i.e. what happens with scratched lenses?
- Standardisation
  - Can we have similar standards for platforms / vehicles / contexts?
  - Who is responsible of enforcing these?
  - What could a translation infrastructure look like?
- Transferability of IP
  - Can the intellectual property also be used elsewhere?
  - How applicable are autonomous technologies to other sectors? (i.e. car to rail and aviation etc.)
- Availability
  - What is the lead time of a technology implementation?

- Are differences in the lead time to implementation and lifetime for cars vs. planes, trains and ships hindering the introduction of certain autonomous technologies?