Lounges on wheels?

Dr Cyriel Diels | Academic Director | National Transport Design Centre | Coventry University | UK
Physical modelling

15 metre milling machine
Workshop facilities
Clay modelling
Hard modelling
3D printing
Digital modelling & visualisation

3D power wall
3D projection mapping
Z-Space
AR / VR / Mixed Reality
Unity
Universal design of sustainable mobility

Designed to be accessed, understood and used by all

Low-carbon and low-emission

Comfort and wellbeing
“Mobility in cities is all about space. Uber and driverless cars don't solve the problem” (Brent Todorian)
Pedelec
Enhanced safety and comfort
Usability
New (low carbon) vehicle categories
Regulatory framework
Infrastructure
Culture & legislation
Cracks in the ridesharing market—and how to fill them

By Russell Hensley, Asutosh Padhi, and Jeff Salazar
Maximise space for shopping and deliveries

Ridesharing can adapt for multiple passengers, including small children.

Smarter design adapts for private, social, or business needs

Seating design
Pressure mapping
Validation of overall seat comfort
Seating design for automated vehicles
Impact of visual appearance
Postural analysis
Design review

Project: Visual appearance and comfort (Tugra Erol)
Biomechanics

In-house biomechanics model; Motion capturing; Ingress egress analysis; Luggage handling on moving vehicles; Comfort modelling
Urban Air Mobility
Performance and handling qualities
Human Systems Integration
Powertrain
Safety & certification
Design
Passenger UX

Project: eVTOL exterior design exploration (Dean Mangurenje)
Automated Vehicles
Passenger experience
Last mile mobility solutions
Interior design
Motion sickness
System trust
HMI
Benefits of Automation

• Travel-based multitasking
• Subjective well-being
Mario Bellini’s ‘kar-a-sutra’: A ‘mobile human space’ as an antidote to the cramped, mundane and restrictive automobile design
Rearward facing seating
Panoramic roofs & large DLOs
No windows or “display windows”
Frivolous with space
Large displays... and lots of them
Awkward positions for HMI use
Content consumption not creation
Pleasurable?

Safe?

Usable?

Comfortable?

Productive?

Designed for people?

... Lots and lots of screens!?
• Radical **cockpit redesign** for future electric AVs

• Impact of **task engagement** on thermal comfort (i.e. from driver (today) to passenger (future))

• People’s **mental models** of cooling and heating and how Human Machine Interface (HMI) approaches may nudge occupants towards more effective and efficient HVAC use, and

• **Impact of vehicle interior** form, shape, colour, and materials characteristics on our thermal comfort perception.
screens became car sick after just 10 minutes. Positioning onboard screens higher, having passengers sit more upright and keeping the environment cool and the air moving can help prevent motion sickness, designers say. A definite no-go is the idea some have floated of replacing glass with giant video screens that project images rather than let passengers see outside.

“I don’t understand about some of these futuristic ideas – why is it every time there’s an autonomous concept, there’s a big screen in front of the driver?” Hyundai-Kia design chief Peter Schreyer tells Car and Driver magazine. “What’s wrong with windows? If you’re being driven, aren’t you going to want to look going to fit in a (Driving) lane,” Clough says.

In addition there are regulatory issues that have to be addressed, because all safety standards are written for forward-facing seats, and even out-of-position, unbelt-
Absence of vehicle control
Reduced ability to anticipate the future motion trajectory

Engagement in non-driving tasks
Reduced anticipation and conflicting motion information provided by the visual system and vestibular system

Alternative seating arrangements
Inability to anticipate the future motion path and conflicting motion cues

Impact of display position & peripheral vision

• Head Up vs Head Down Displays

Impact of display position & peripheral vision

• Head Up vs Head Down Displays

Design implication: Position displays to allow occupants to see the outside world
Outstanding research questions

- **Display size**: How much peripheral vision is required?
- **Display location**: Which part of the visual field is particularly important?
- **See-through / AR display**: How effective and acceptable (e.g. readability)?
- **Display content**: Impact of media (text/graphics, video)
- **Self management**: Strategies to reduce motion sickness & HMI design
Countermeasures: anticipatory motion cues

• Auditory motion cueing
Countermeasures: anticipatory motion cues

- Auditory motion cueing

18 minute urban drive while performing visual search task on head down display
Countermeasures: anticipatory motion cues

• Auditory motion cueing

Key findings
• 96% of participants reported motion sickness within minutes
• 50% of participants had to terminate trials prematurely due to symptom severity
• Two incidences of vomiting (!!!)
Countermeasures: anticipatory motion cues

- Auditory motion cueing

Mean sickness rating over time

- No cueing
- Cueing
Countermeasures: anticipatory motion cues

- Auditory motion cueing

Key findings
- 96% of participants reported motion sickness within minutes
- 50% of participants had to terminate trials prematurely due to symptom severity
- Two incidences of vomiting (!!)
- Anticipatory motion cues are effective but cannot avoid motion sickness altogether
- Cues can be perceived as cognitively demanding and annoying: acceptable and effective cues significant design challenge

Design implication: Countermeasures can provide some relief, but are no silver bullets!
Countermeasures: anticipatory motion cues

Outstanding research questions

• Impact of motion cueing *timing*
• Impact of motion cueing *information specificity*
• Impact of motion cueing *sensory modality*
• *User acceptance*: distraction and frustration potential of different cues
Alternative seating arrangements

• Forward vs Rearward facing

Alternative seating arrangements

- Forward vs Rearward facing

2 x 30 minute drives each consisting of urban and motorway profiles
Alternative seating arrangements

- **Forward vs Rearward facing**

**Key findings**
- Increase in motion sickness by a **factor of 5** when traveling backwards
- **100% of participants** reporting higher levels of motion sickness in rearward facing position
- **Urban driving** more provocative than motorway driving
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- **Forward vs Rearward facing**

**Key findings**
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- **Urban driving** more provocative than motorway driving
- **Rail studies** also show preference for forward facing despite **benign motion profiles** compared to AVs

**Design implication**: Avoid rearward facing seating arrangements

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Alternative seating arrangements

• Forward vs Rearward facing

Outstanding research questions

• Can we *augment* the environment to compensate for a lack of outside view and ability to anticipate future motion?
• Relative effectiveness of different *sensory modalities*
• User *acceptance* and interference with other in-vehicle tasks
• Can *innovative seating* and *interior design* compensate or facilitate self-management?


Sivak (2018)
Joint Industry Project – Motion Sickness

**PREVENTING MOTION SICKNESS IN AUTOMATED VEHICLES**

- Pre-competitive research led by Coventry University and TNO (Netherlands)
- Duration: 2 years
- Directly funded by OEM and Tier 1s
- Q4 2018 start
- Focus on empirical evaluation of major contributing factors *vehicle dynamics* and *visual conditions*
- Facilities: motion sled, simulation, test track and on-road studies
- Mathematical model and software design tool to predict sickness levels depending on design choices
Project: Last Mile Mobility concept (Joscha Wasser)

Wasser, J., Diels, C., Baxendale, A., Tovey, M., 2017. Driverless Pods: from Technology Demonstrators to De-sirable Mobility Solutions. 8th International Conference on Applied Human Factors and Ergonomics (AHFE 2017), 17-21 July, Los Angeles, CA, US.

Concluding remarks

• The **passenger experience** will become the key requirement and differentiator

• New technologies and services (e.g. automation, AR, VR, MaaS) allow for **new behaviours and experiences**

• But still largely driven **by technology and design push with limited appreciation of human factors**

• Ultimate experience may not be satisfactory **risking public acceptance and uptake**

• **Motion sickness** is a major challenge for key AV business cases of “Travel-based multitasking” and “Subjective well-being”

• **HMI a double-edged sword**: Poor design will make matters worse, innovative HMI solutions can prevent discomfort and enable new travel experiences
Any Questions?

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