Remote Operation: A Human Factors Perspective

Dr Catherine Harvey

HFRG Team: Hannah Parr, Dr David R Large, Prof Sarah Sharples
Human Factors Research Group
Work on Remote Operation

ServCity (Innovate UK, CCAV), Burnett, Harvey, Large, Hallewell (Jan 2020 – March 2023)
- Project deliverable on teleoperation workstation user requirements, involving interviews with key stakeholders and refined task analysis activity

MSc HF Final Project ‘Goal-Directed Task Analysis for CAV teleoperation’, Callum Thomas (2021)
- MSc final project, developed Goal-Directed Task Analysis and information requirements specification, based on analysis of Remote Operation across domains (video analysis – Covid)

PhD on Remote Operation of Autonomous Vehicles, Hannah Parr (2021 - )
- Aims: define levels, scenarios; determine role requirements; simulate/evaluate scenarios
- Parr, Harvey & Burnett (Under review) Investigating levels of remote operation in high-level on-road autonomous vehicles using operator sequence diagrams. *Cognition, Technology and Work.*

UoN-funded Remote Operation Simulator Development (Jan 23 - )
- To simulate RO/control centres across domains, linked with driving simulator
The AV Context

- Focus on Levels 4 and 5
- Vehicle occupant/s cannot drive
- Typical use case is AV taxi service
  - Significant understanding of this from ServCity Project

[www.ServCity.co.uk](http://www.ServCity.co.uk)
Nissan, Connected Places Catapult, Hitachi, TRL, University of Nottingham, SBD Automotive
## Defining RO Roles

<table>
<thead>
<tr>
<th>Role</th>
<th>Description</th>
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<tbody>
<tr>
<td>Remote Driving (RD)</td>
<td>‘Remote control over the dynamic driving task (DDT) of an AV for a limited time period, where RA, RMa and RD are unable to resolve issues of vehicle function.’</td>
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<td>Remote Management (RMa)</td>
<td>‘Remote provision of instructions to AV to initiate system actions where the AV systems are unable to proceed independently. May also cover fleet management.’</td>
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<td>Remote Assistance (RA)</td>
<td>‘Remote provision of assistance and/or information to the AV user or external agents in close proximity to the AV (e.g. emergency services or vehicle recovery).’</td>
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<td>Remote Monitoring (RMo)</td>
<td>‘Remote observation of AV, user state and environmental factors, supporting the prediction and identification of issues to inform decision making.’</td>
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RO Scenarios

- Path disruption
- **Weather disruption**
- Insufficient range/fuel
- AV will not begin journey
- Mechanical failure
- Sensor perception error
- **Vehicle damage (collision)**
- Occupant medical emergency

Based on analysis of:
State of California Department of Motor Vehicles (2021, 2022) *Autonomous vehicle Disengagement Reports* (electronic data set), [https://www.dmv.ca.gov/portal/vehicle-industry-services/autonomous-vehicles/disengagement-reports/]
And other literature
Offer a way of modelling and graphically representing interactions between ‘agents’

- In a RO scenario, agents are **computing systems, AV occupant/s, Remote Operator/s**, and **external agents**
- Agents are represented in ‘swim lanes’, interactions are depicted over time

Operator Sequence Diagrams (OSDs)

OSDs have been applied and validated previously:


**OSD**

1. Weather disruption

Key findings:
- Remote management with potential for remote driving
  - But RD is ‘last resort’
- Need for RO-AV occupant communication
- No external agent involvement
Osd

2. Vehicle collision

Key findings:
- Significant external agent involvement – need for comms
- Need for RO-AV occupant communication
- No direct RD
- Simultaneous Remote Assistance and Remote Management
OSD Main Findings

1. Remote Assistance and Remote Management occur frequently (more than expected and more than remote driving) and together

2. Remote Driving is required infrequently, as a ‘last resort’

3. Scenarios are complex, with multiple ‘agents’, therefore Shared Situation Awareness is significant – needs further research, focusing on vehicle occupants and other external agents

4. Like driving, Remote Operation will operate at different levels of automation, which will influence the human role
Michael, 38

Michael works from home part-time running a business. He is the primary carer for his two children - a daughter aged 13 and a son aged 6. His daughter, who has a visual impairment, goes to the local secondary school and his son to the primary school.

He uses taxis everyday for the school-run as his wife works late/early shifts and needs the family car. He would take a bus, but the primary school isn’t on the route and his daughter struggles to use public transport when it’s busy.

Michael would like go out more with the children at the weekend but struggles if he doesn’t have the family car. He’s considering joining a ‘car share’ scheme as he likes to drive but can’t afford a second car.

“I wish taxi drivers has disability awareness training - my daughter’s disability is not always obvious - I think technology could help”

“We all know the drivers well now – it’s nice that we can just have a chat and they always ask the kids what they are up to”

Michael has an Apple iPhone for business and an Android phone for personal use.
The family has an Apple Mac at home and several tablet devices which all the family use.
They also have two Amazon Alexa devices, one in the kitchen and one in the home office. These help Michael’s daughter to access music and other content.

Travel & Transport

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<th>Top 3 modes of transport</th>
<th>Top 3 reasons for taxi usage</th>
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<td>Taxi</td>
<td>Caring</td>
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<td>Shared car</td>
<td>Business</td>
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<tr>
<td>Walking</td>
<td>Leisure</td>
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Willingness to share a taxi

Technology and Income

Technology acceptance

Openness to experience

Budget
Mary, 81
Mary lives in sheltered housing in a small town. She is very active in her local community. However, she has mild hearing loss, and she finds it difficult to walk, she often needs to use a walking stick.

Her husband died 5 years ago and as she has never driven, she relies on the local bus to get about. She’s happy to take the bus, but the service is limited and it’s hard for her to stand and wait if it’s late. She will ask friends for lifts but doesn’t like to impose unless it’s important.

If she goes out in the evening, she prefers to get a taxi knowing it will take her door to door, so won’t have to walk far in low light.

Mary has an old Android smartphone that her son gave her so they can always contact each other when she’s was out and about, but she finds it hard to hear on it, particularly when outside. She prefers to use her landline for making any arrangements, as she can hear better and finds the raised buttons much easier to press than those on the flat smartphone screen.

“I know I can be a bit slow, but when taxi drivers don’t show up because they recognise the address (sheltered housing), it’s very frustrating”

“I like to be independent, I don’t like to rely on my friends for lifts, but some ‘out of town’ places are so hard to get to otherwise”

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Shared Situation Awareness

- Control Room
  - Remote Operator
  - Information requirements
  - Additional RO requirements

- Road Environment
  - Michael
    - Information requirements
  - Michael's child
    - Information requirements
  - Mary
    - Information requirements
  - AV
    - Information requirements

- External agent
  - Information requirements
Further Human Factors Issues for RO

- Misuse, Abuse and Disuse
  - Important to examine the negative issues around RO

- Training needs
  - Do particular skills and experience make a better RO?

- Trust in Remote Operation
  - From the various perspectives of system actors and general public

- Use of VR/AR/XR in remote operation
Thank you

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