A CPM-GOMS-model of lane changes on highways

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Agenda

1. Modelling of driver behaviour and distraction
2. A modelling workflow
3. Drive-GOMS
4. Empirical study
5. Motor operators
6. Outlook
Modelling of driver behaviour and distraction

Why do we study driver distraction?

"diversion of attention from the primary driving task"
- due to an additional task
- reduction of situation awareness, decision making

Trezise et al. (2006)
Modelling of driver behaviour and distraction

Mitigating distraction

"Continental’s concept vehicle recognizes **driver distraction** and is able to direct the driver’s attention towards a dangerous situation."

*Ambient Light*, Projekt "Adapt!Ve", DLR 2016
Modelling of driver behaviour and distraction

Requirements

quantitative predictions
• computational
• functional

usability
• effective
• efficient
• you can learn it on your own

specific support for design of
• driver information systems
• vehicle automation
• infrastructure

The appropriate level of abstraction

"Find the way from the main station to the TEAP."

There are no right or wrong models. Only useful / usable ones.
Modelling workflow

framework: driving task and traffic system

task analysis

explorative study -> explorative task model

targeted study -> validated task model

cognitive + computational models
An example task
Basic approach: **CPM-GOMS**


- **Cognition**: prepare, prepare, validate
- **Perception**: aural, listen, parallel
- **Motor**: left hand, move, press_down

Time
Empirical study

measuring vehicle "ViewCar"
  • recording of all vehicle data
  • 8 video cameras
  • eye- and headtracking with Smart Eye Pro 6.1
Empirical study

convenience sample:
- me, my colleague, and a student
- 33 / 31 / 22 years
- all sufficiently experienced drivers
Empirical study
### Motor operators: Template

<table>
<thead>
<tr>
<th>resource</th>
<th>system unit</th>
<th>operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>right_foot</td>
<td>throttle</td>
<td>rest</td>
</tr>
<tr>
<td></td>
<td></td>
<td>hold</td>
</tr>
<tr>
<td></td>
<td></td>
<td>press_down</td>
</tr>
<tr>
<td></td>
<td></td>
<td>release</td>
</tr>
<tr>
<td>brake</td>
<td>rest</td>
<td>hold</td>
</tr>
<tr>
<td></td>
<td>press_down</td>
<td>release</td>
</tr>
<tr>
<td>floor</td>
<td>rest</td>
<td>move</td>
</tr>
<tr>
<td>left_hand</td>
<td>non_functional_unit</td>
<td>rest</td>
</tr>
<tr>
<td></td>
<td>steering_wheel</td>
<td>turn_left</td>
</tr>
<tr>
<td></td>
<td></td>
<td>turn_right</td>
</tr>
<tr>
<td></td>
<td></td>
<td>hold</td>
</tr>
<tr>
<td>indicator_lever</td>
<td>prepare / be ready</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lift</td>
<td></td>
</tr>
<tr>
<td></td>
<td>press</td>
<td></td>
</tr>
<tr>
<td></td>
<td>tap_up</td>
<td></td>
</tr>
<tr>
<td></td>
<td>tap_down</td>
<td></td>
</tr>
<tr>
<td>&lt;from&gt;:&lt;to&gt; move</td>
<td></td>
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</tr>
</tbody>
</table>
Outlook: Drive-GOMS

automation and extension
• simulator study with fixed situations
• automated motor operator coding

validation
What if you could see what your model does?

goals

perceptive operators

scene representation
Will it work? We have to try!

"[To do] predictive human performance modeling (...), the real bottleneck is in the task analysis process. (...) What is missing, and badly needed, is a demonstration that one can start with a conventional task analysis (...) and then proceed systematically to a usefully accurate computational cognitive model, with no 'hand-waving' in between."

David Kieras & David Meyer
authors of the EPIC cognitive architecture
Thank you for your attention!
Drive-GOMS

Requirements

domain specific GOMS
  • measurements for operators
  • systematic relation to system elements
  • integration of goals
  • methods and selection rules
usability
  • documented procedure for modelling of goals, cognitive and perceptual operators
  • suitable statistical procedures to identify operator sequences
validation
  • procedures for validation
  • metrics for validation