Understanding User’s Experience of Ride Quality and its Relationship with Profile

Alex Wright

ERPUG 2019
“Routine” data collection on the English Strategic Road Network

- Network level
  - TRACS – strategic roads
  - SCANNER – local roads
  - SCRIM – all roads
  - TSD (TRASS, strategic roads)
- TRACS - an “end result” survey providing profile, rutting, geometry, cracking and ravelling, retro-reflectivity of road markings
  - Lane 1 and Lane 2 annually
  - Lane 1 of Slip roads every two years
  - Outer lanes every two years
  - Approximately 30,000km / year
- (Local roads as SCANNER – 150,000km/year)
Surface condition - TRACS

- TRACS provides raw condition data (RCD), applied for:
  - Rutting
  - Cracking
  - Texture depth
  - Fretting/Ravelling
  - Geometry
  - Night-time visibility of road markings
  - **Ride quality**
User surveys show road surface quality is important to users

- Relating comfort to road surface quality is complex
- FORMAT – user perception is influenced by many factors
- EXPECT – Objective measures (indicators) of comfort do not agree with focus group studies (additional factors – visual, bumps, which can combine)
- UK DfT – ‘Users notice the poor bits’, ‘initial view is not objective view’
Ride quality to assess condition and user experience

- In UK ride quality is expressed as 3m, 10m 30m Enhanced Longitudinal Profile Variance
  - Criteria have been established to support condition assessment
  - These were established >25 years ago
    - Different users, vehicles, expectations
- Since then user experience has been assessed using questionnaires
  - Not quantitative?
  - Questionable outcomes?
- **Are we still confident in our approach to quantifying and rating ride quality?**
- E.g. District of Columbia reviewed their standards in 2015, asking users their views and comparing with condition data
  - Users might tolerate **rougher** roads?
  - But, using IRI and with thresholds lower than SRN thresholds

<table>
<thead>
<tr>
<th>Ride Quality</th>
<th>IRI threshold by classification (m/km)</th>
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<tbody>
<tr>
<td>Motorways and rural dual carriageways</td>
<td>Urban dual carriageways</td>
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<tr>
<td>Good</td>
<td>2.7</td>
</tr>
<tr>
<td>Moderate</td>
<td>5.2</td>
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<tr>
<td>Poor</td>
<td>6.5</td>
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<th>New Pavement IRI Limits</th>
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<td>Freeways</td>
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Updating our objective criteria – a practical study

• We would like to:
  • Have a method to quantify the experience of road users that enables direct comparison with profile measurements
  • Update our understanding of how users experience is represented by profile
  • Hence confirm/update the parameters and thresholds used to quantify user experience of comfort
  • This required a new method that would provide direct quantitative information on user experience
    • Developed a simple App
    • Users record their views on comfort and bumpiness during a journey
    • All views recorded relative to GPS coordinate
    • Will allow comparison with profile data
    • Pilot trial used to develop and refine the design ahead of a larger scale user trial
Developing and refining an App-based approach – Pilot trial

- **Comfort**
  - We selected a scale with “negative” attributes at one end and “positive” attributes at the other
  - Using a sliding scale was found to be impractical
  - Selected five response options to capture a range of severities.
  - Much debate about the terminology!
  - Users asked to provide an input every 30s (~500m) via a “beep”

- **Bump**
  - Work on small (“local”) roads suggested that users respond to bumps differently than general ride comfort
  - We asked users to record when they experienced a bump using a separate button and a scale three bump severities
  - A “combined survey” was carried out, recording comfort and bumps on one App
Developing and refining an App-based approach (comfort)

- Testing - repeat journeys
  - Same person in front passenger seat
  - Same person front vs. rear
  - High level of repeatability

- It's not safe for drivers to operate an App
  - Our pilot trial investigated options

- Driver vs Passenger
  - High level of ‘repeatability’ in 3 of 4 tests
  - Suggests that experience not strongly affected by position of participant
  - But quite a large difference in views
Developing and refining an App-based approach (bump)

- Consistent recording of bumps is more challenging
  - Pilot showed ‘between participant’ variability
  - We concluded that the lack of consistency arose from complexity, explanation and terminology for “bump”
  - “Bump” was refined for the full trials, and separated from “comfort”
- Further variables we needed to control:
  - Vehicle type – keep same for all users
  - Speed – keep as similar as possible
  - Drivers – professional and keep same if possible
  - Route – must have range of roughness
  - Weather – avoid rain etc.
  - Traffic – not in peak times and ideally similar for each user run
  - Understand impact of fatigue
Applying an App based approach – user trials

- Route selection
  - Strategic roads - M4 and A34
  - To ensure “range of roughness” - Local Authority A roads
  - Wide range of age and condition

- Participants
  - 900 participants canvased
  - 70 recruited
  - Demographic spread (but slightly “old”)

- Vehicles
  - 2019 Seat Leon Hatchback (x2)
  - Professional Drivers (4)

- Surveys
  - Users completed a questionnaire on their views on network condition
  - Then a driven comfort survey using updated App
    - Then a bump survey (or vice versa)
  - 140 driven surveys, average journey time 45 minutes each
App data was aligned to a common route to ease data analysis
Route “defined” by the centre line of a profile (HARRIS3) survey
- Software written to ‘snap’ data from each user run to this route
- Hence each user’s data is defined as coordinate, section and chainage
- Resampled to 10m
- Essentially delivers ~70 user comfort and bump ratings for each 10m length of the route

Questions to answer:
- What is the “true” user roughness of each length?
- How does this relate to profile?
- What does the mean for network ride quality assessment?

Work recently commenced....
- Initial observations follow here
User experience

- Does the “demographic” affect ability to collate/combine the data?
  - Little evidence of differences due to:
    - Time of day
    - Start point
  - Undertaking comfort or bump survey first
    - Evidence of “fatigue” – rougher if surveyed comfort second
  - Age
    - Reporting higher levels of roughness by older drivers (?)
  - Gender
    - Little difference for comfort, but males reported more bumps
  - Opinion of the network
    - Users that expressed dissatisfaction in the questionnaire may report the route to be rougher?
  - But differences small enough to give confidence that data can be combined to create a “user” value for each length....
Understanding user experience

- **What is the “true” user comfort value?**
  - Combined the 60+ user data to express as
    - Mean
    - Weighted (for user “bias”) mean
    - Percent reported in category 4 or 5 (i.e. highlighting the poor lengths)
  - But well correlated (note different scales)
    - Suggests a remarkably consistent dataset
    - Simplifies “core” analysis

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<th>User Comfort Level</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Very Smooth</td>
</tr>
<tr>
<td>2</td>
<td>Smooth</td>
</tr>
<tr>
<td>3</td>
<td>Neutral</td>
</tr>
<tr>
<td>4</td>
<td>Rough</td>
</tr>
<tr>
<td>5</td>
<td>Very Rough</td>
</tr>
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</table>
Relating user comfort to profile

- Which profile parameter best reflects user experience
- And how should we report it?
- Initial work is focusing on Variance (LPV), to establish approach
  - We will look at IRI
- 3m LPV, reported every 10m... lots of noise
Relating user comfort to profile

- User data reflects experience of the road over longer lengths (30s ~ 500m)
- Clearer relationship user->profile when expressed over longer lengths (300m moving average, every 10m)
- Indicates that
  - App based approach is delivering “sensible” data
  - Profile parameters reflect comfort reported by modern users?
  - The relationship is non-linear (User range constrained 1-5)

Blue: User average
Green: 3m LPV (300m MA)
Relating user comfort to profile

- Both direct relationship and considering the LPV in “bands” supports user vs profile threshold investigation
  - There is a wide overall range
  - Shows the range of “noise”
- And still need to answer question over what the “threshold” user metric should be
  - Mean?
  - Category 4&5?
Relating bump to profile

- User bump is an instantaneous record of user experience
- Had expected (from local roads) there would be challenges relating this to profile parameters
- We see notable agreement
  - Also, recording of “user bumps” tracks that of “user comfort”
  - Suggests we can use profile parameters to understand user experience of both general ride quality and bumpiness?

3m LPV (black) vs 50m sum of bumps (orange)
We are revisiting how we understand user experience of comfort on UK strategic roads, and how profile represents this

- Approach in UK can be extended back many years

We have developed an App based approach to **quantify user experience** of comfort and bumps
- User trials have provided a robust consistent dataset
- A number of potentially confounding factors are seen, but do not seem to have had a large effect on the data (driver vs passenger, gender…) – hence generating a “user comfort value”

We are exploring the profile-user relationship to revisit our definition of “rough”
- A clear relationship is apparent with the profile data, probably non-linear
- We have considered UK profile parameters initially but are to investigate IRI, WLP
- We will be examining how this affects our current use of ride quality data to support maintenance
  - E.g. Our 3m ELPV vs. relationship suggests that category 3 might be above what users consider to be 4?

We will be investigating the influence of bump vs comfort, and effects of combining parameters

This trial may not be enough to support a change in policy - we will be considering further trials to test the outcomes
Questions?

Alex Wright
Chief Technologist

mwright@trl.co.uk
+44 [0]1344 770 264 | +44 [0]7167 648208
TRL | Crowthorne House | Nine Mile Ride | Wokingham
Berkshire | RG40 3GA | United Kingdom