



THE FUTURE
OF TRANSPORT

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

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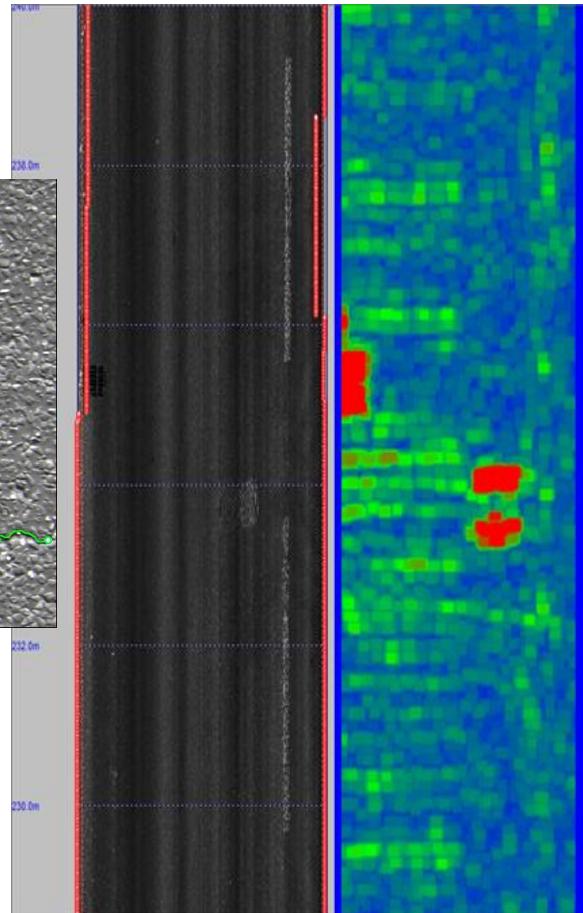
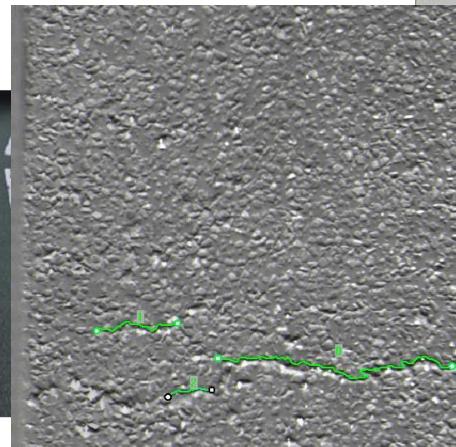
“Routine” data collection on the English Strategic Road Network

- 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)



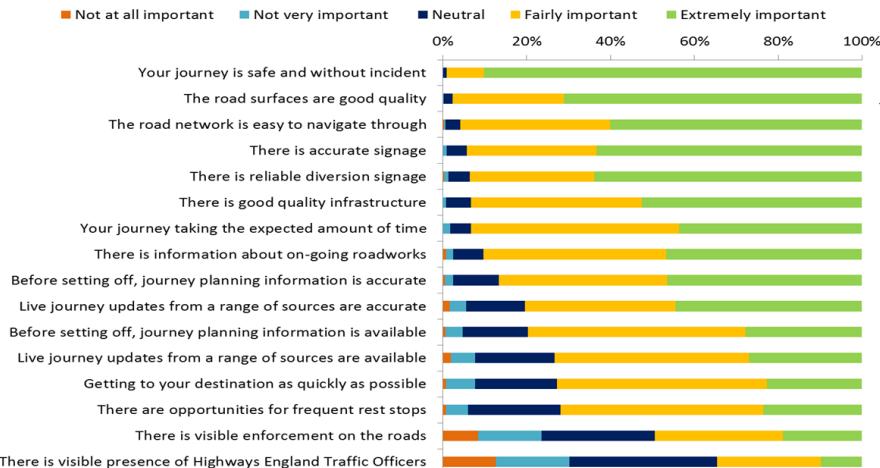
Surface condition - TRACS

- TRACS provides raw condition data (RCD), applied for:
 - Rutting
 - Cracking
 - Texture depth



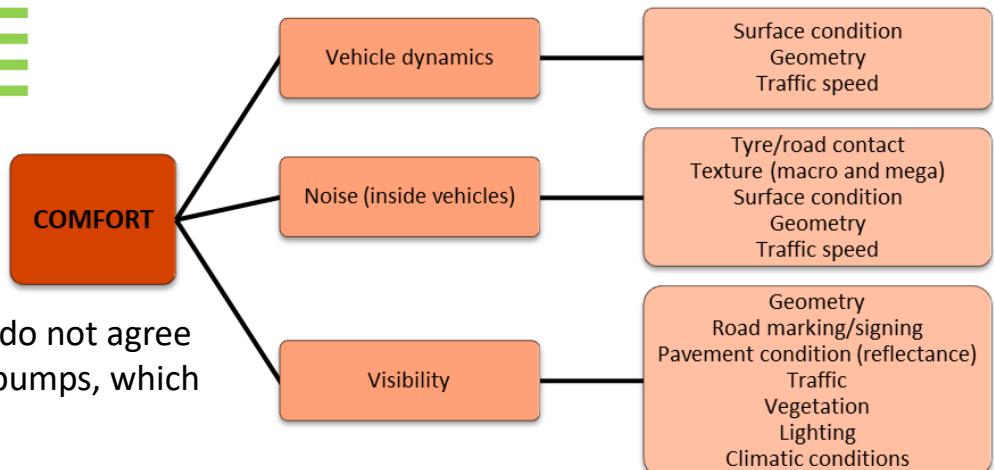
- Fretting/Ravelling
- Geometry
- Night-time visibility of road markings
- **Ride quality**

Ride quality - understanding user experience



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

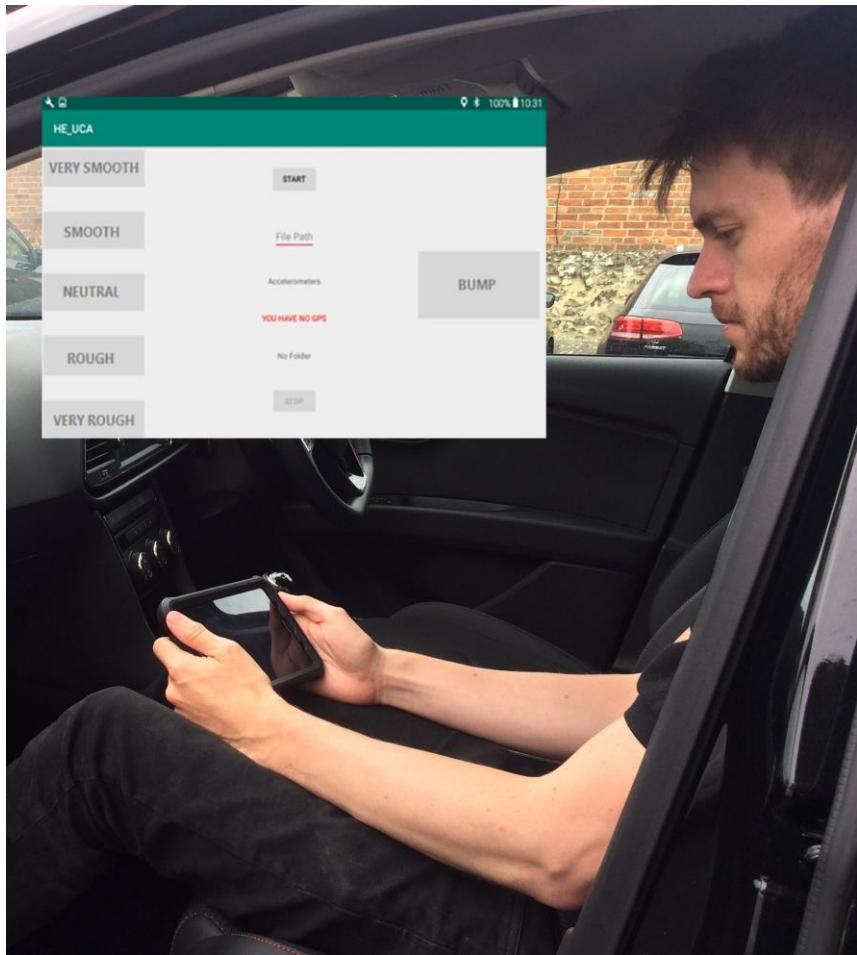
Ride Quality	IRI threshold by classification (m/km)	
	Motorways and rural dual carriageways	Urban dual carriageways
Good	2.7	3.2
Moderate	5.2	5.5
Poor	6.5	7.4

New Pavement IRI Limits	IRI Threshold by Roadway Classification (m/km)	
	Freeways	Arterials/Collectors
Good	1.3	2.5
Acceptable	1.3-2.5	2.5-4.8

Ride Quality	IRI Threshold by Roadway Classification (m/km)	
	Freeways	Arterials/Collectors
Good	2	3
Acceptable	2-3.5	3-4.5

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



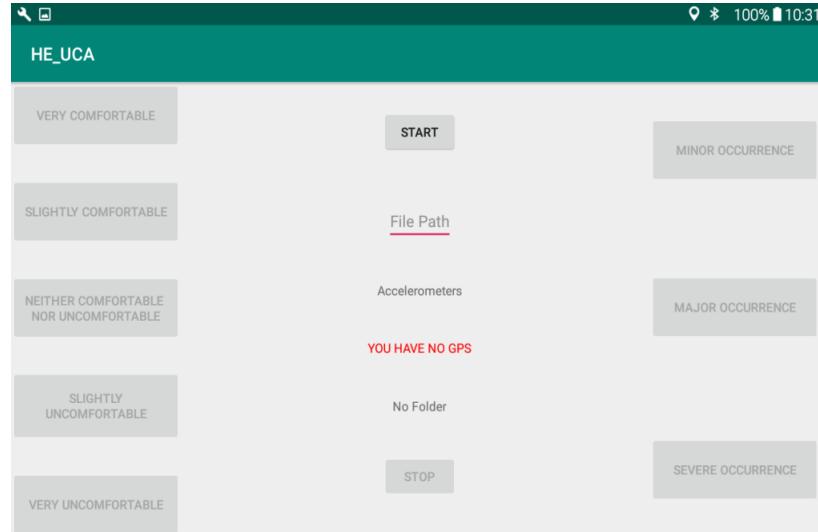
Developing and refining an App-based approach – Pilot trial

- **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”

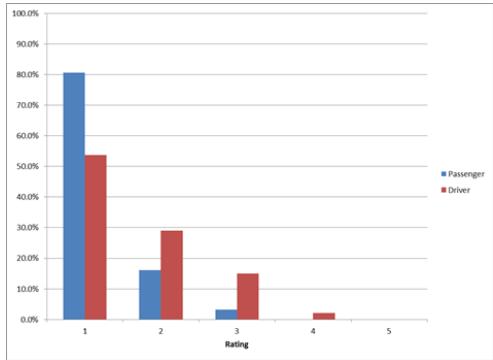
- **Bump**

- 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

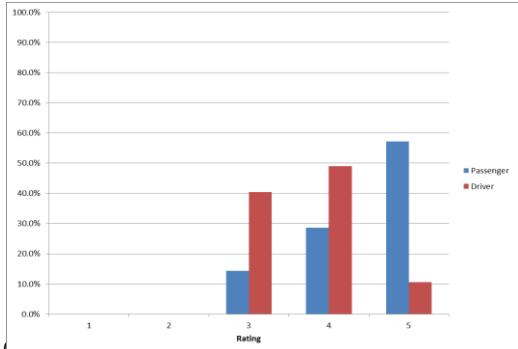


Developing and refining an App-based approach (comfort)

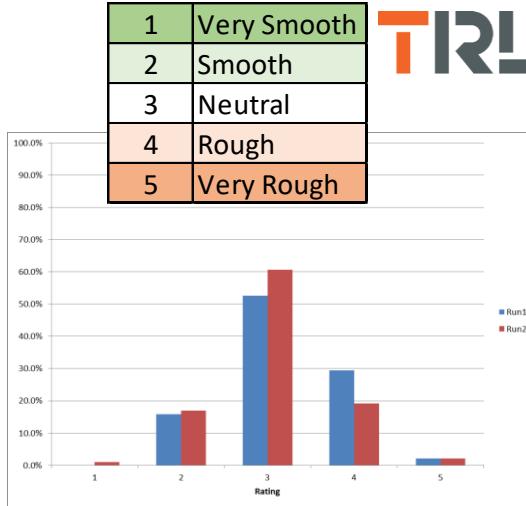
TRL



Same user driver vs passenger
user 1 (above), user 2 (below)

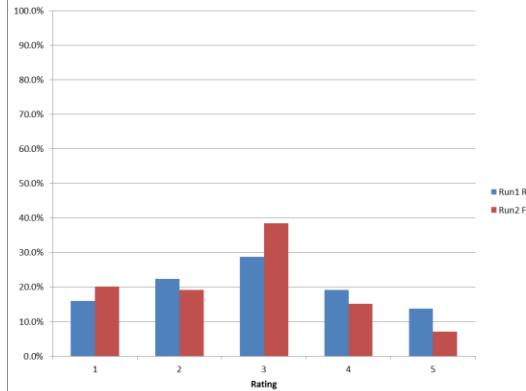


- Testing - repeat journeys
 - Same person in front passenger seat
 - Same person front vs. rear
- High level of repeatability



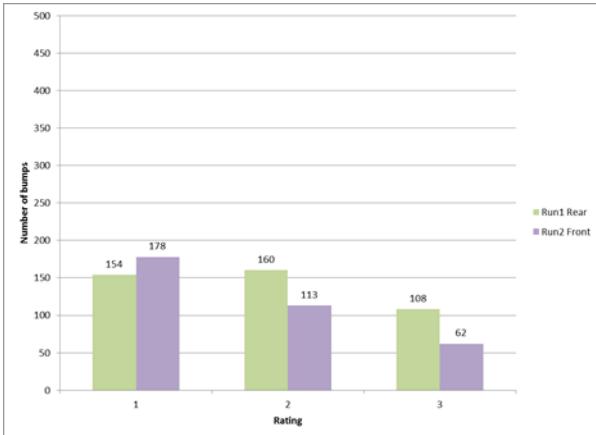
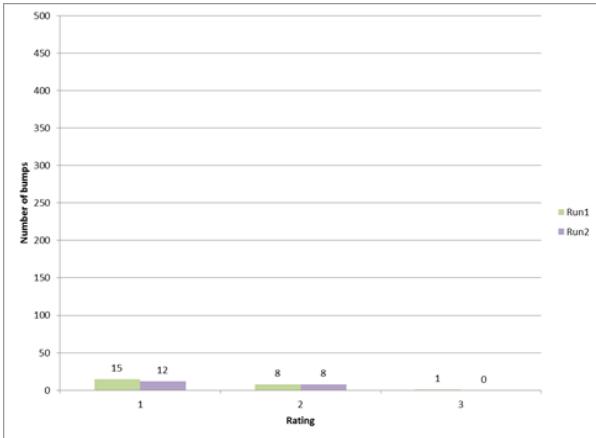
Same user in same seat (above)
Same user front vs. rear (below)

- Its 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



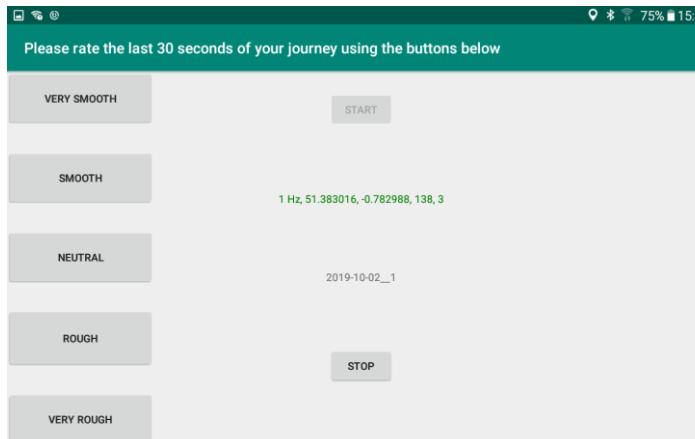
Developing and refining an App-based approach (bump)

- 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



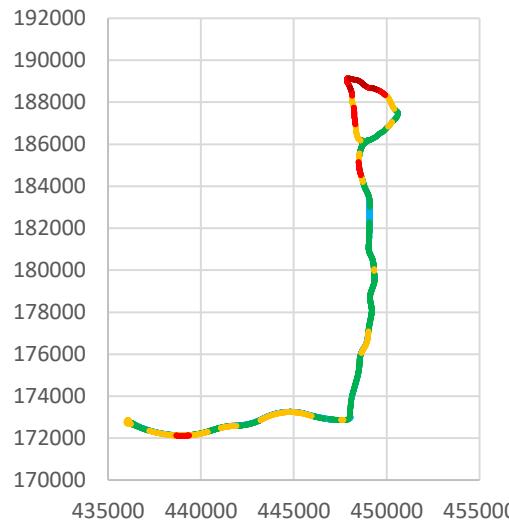
Applying an App based approach – user trials

- 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



Processing...

- 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



• 2-2.5
• 2.5-3
• 3-3.5
• 3.5-4
• 4-4.5

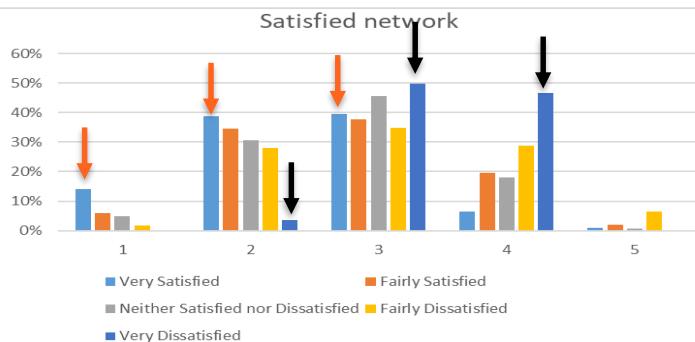
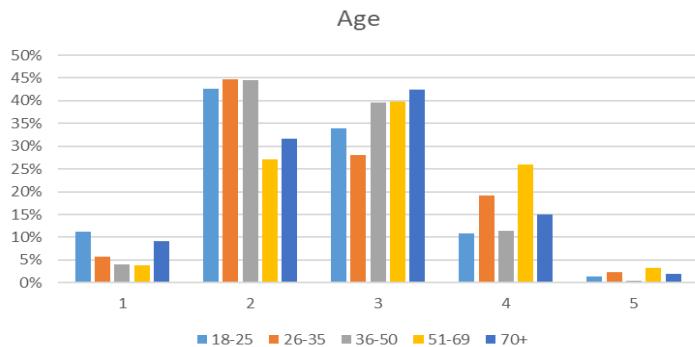
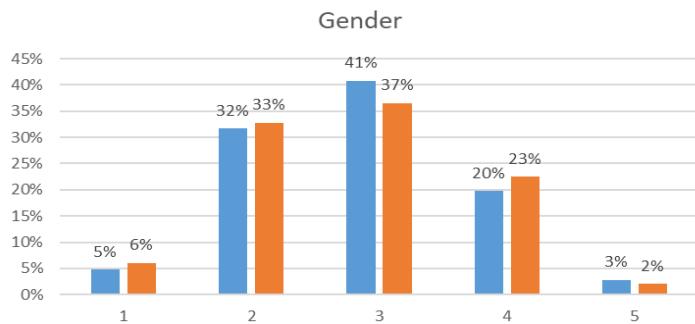


A user rating of 1-5 for each 30s, fitted to 10m lengths:

User experience

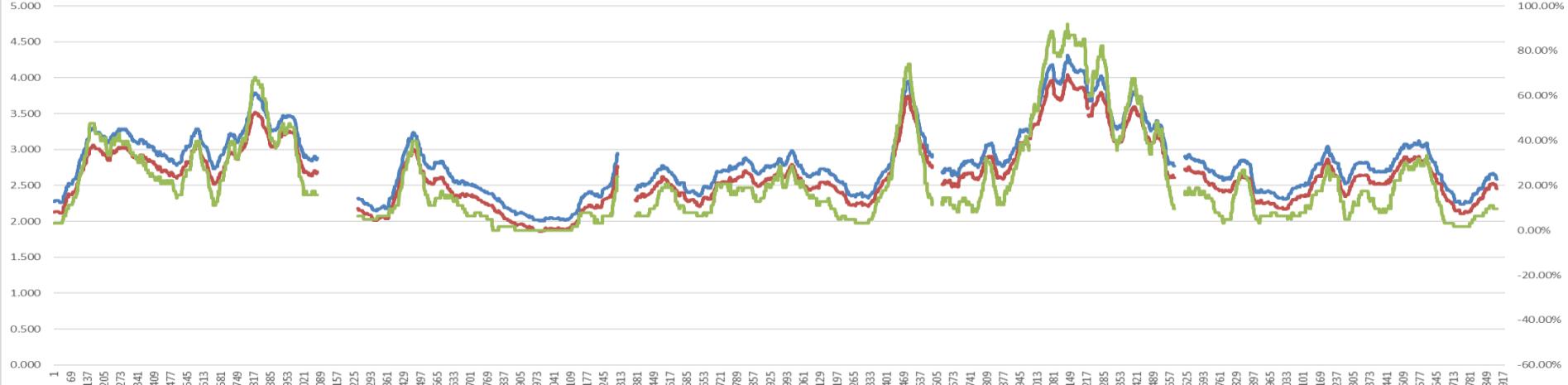
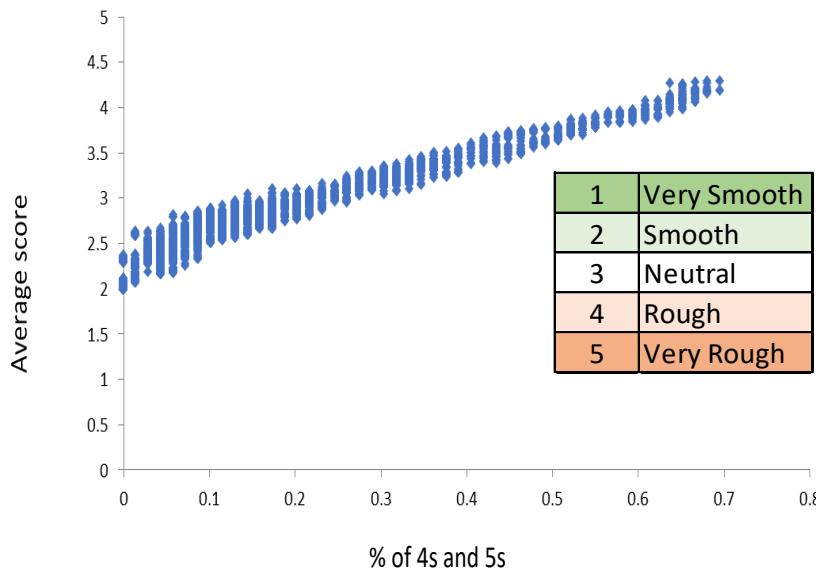
- Does the “demographic” affect ability to collate/combine the data?
- Little evidence of differences due to:
 - Time of day
 - Start point
- Undertaking comfort or bump survey first
 - Evidence of “fatigue” – rougher if surveyed comfort second
- Age
 - Reporting higher levels of roughness by older drivers (?)
- 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....

1	Very Smooth
2	Smooth
3	Neutral
4	Rough
5	Very Rough



Understanding user experience

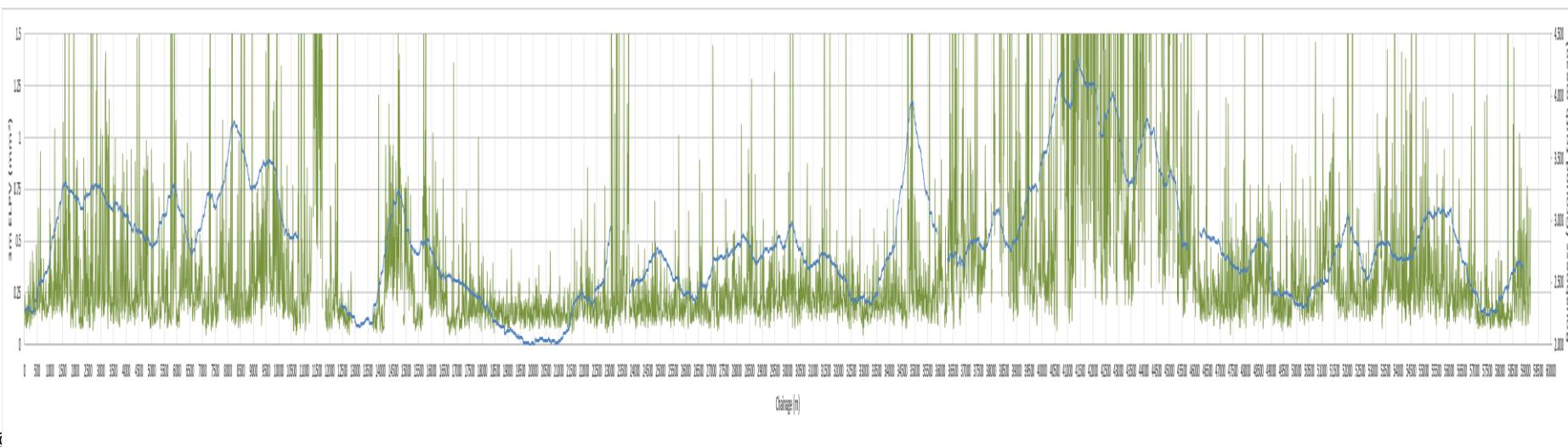
- **What is the “true” user comfort value?**
- Combined the 60+ user data to express as
 - Mean
 - Weighted (for user “bias”) mean
 - Percent reported in category 4 or 5 (i.e. highlighting the poor lengths)
- But well correlated (note different scales)
 - Suggests a remarkably consistent dataset
 - Simplifies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



Relating user comfort to profile

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

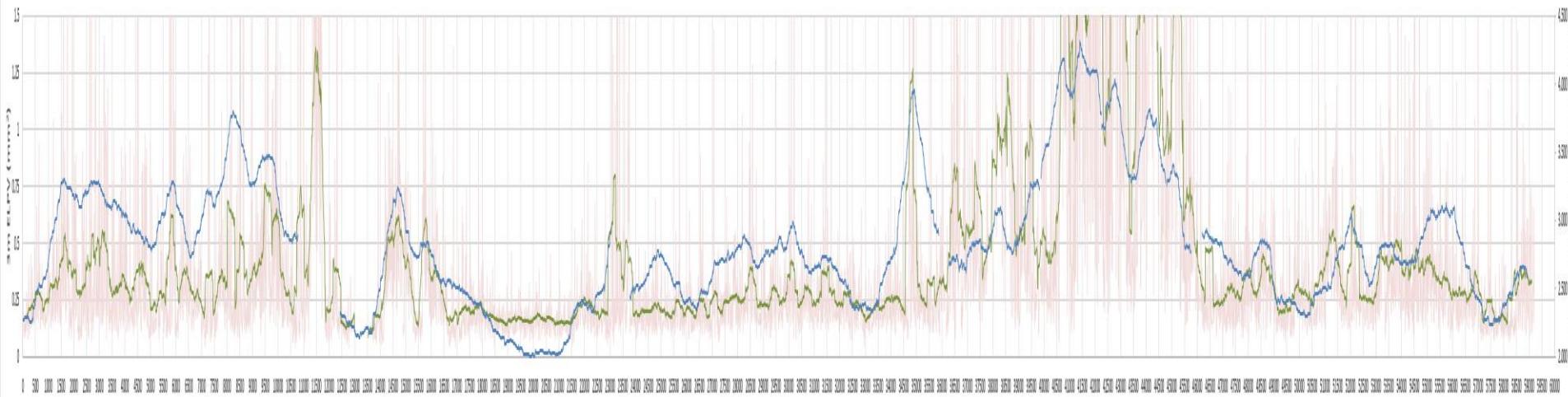
Blue: User average
Green: 3m LPV (10m)



Relating user comfort to profile

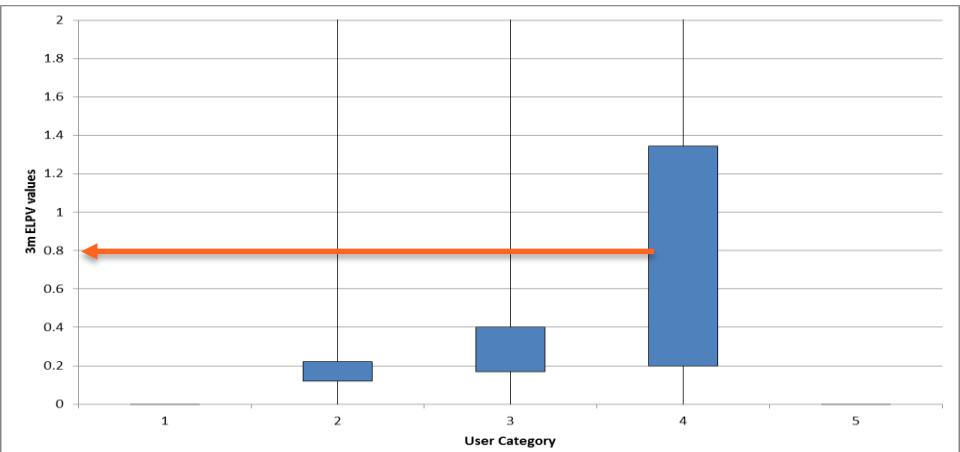
- User data reflects experience of the road over longer lengths (30s ~ 500m)
- Clearer relationship user->profile when expressed over longer lengths (300m moving average, every 10m)
- Indicates that
 - App based approach is delivering “sensible” data
 - Profile parameters reflect comfort reported by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

Blue: User average
Green: 3m LPV (300m MA)



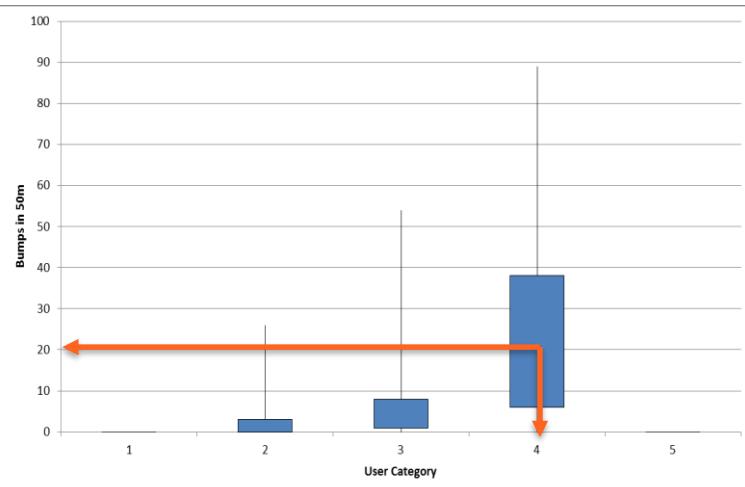
Relating user comfort to profile

- 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?

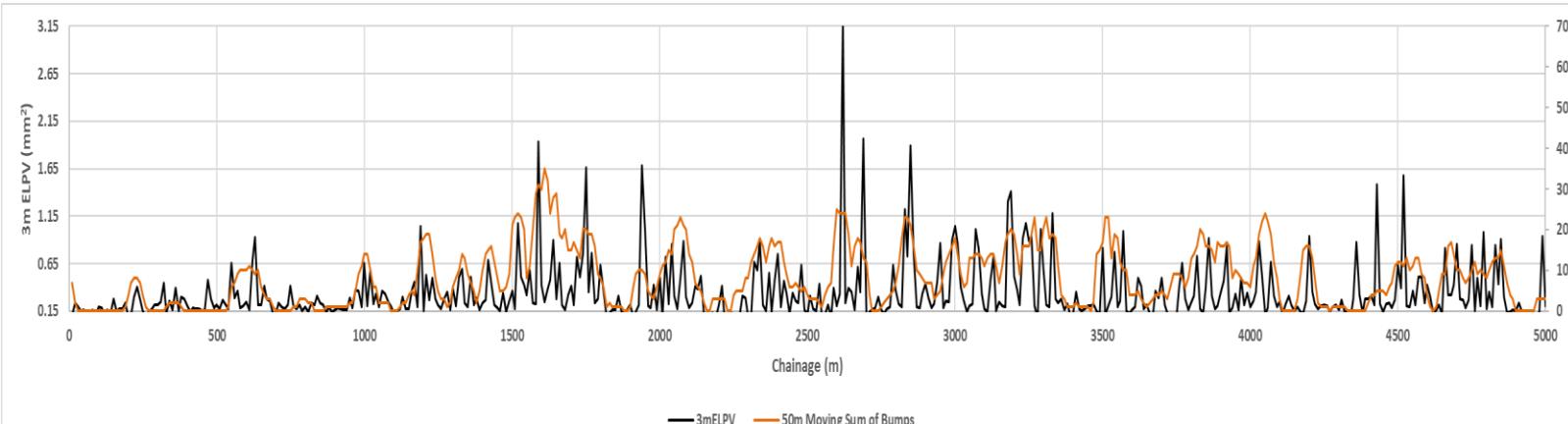


Relating bump to profile

- 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)



Summary - where are we going?

- 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?

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