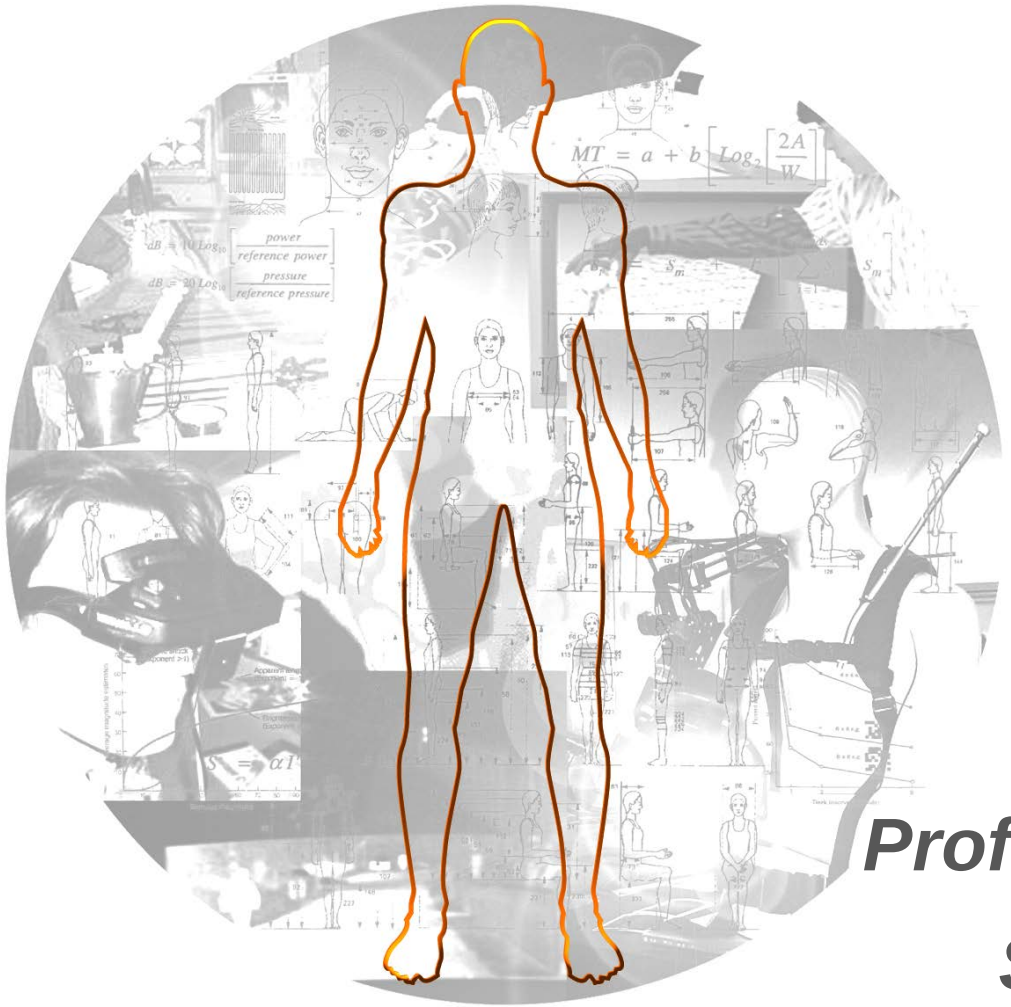
AutoHabLab

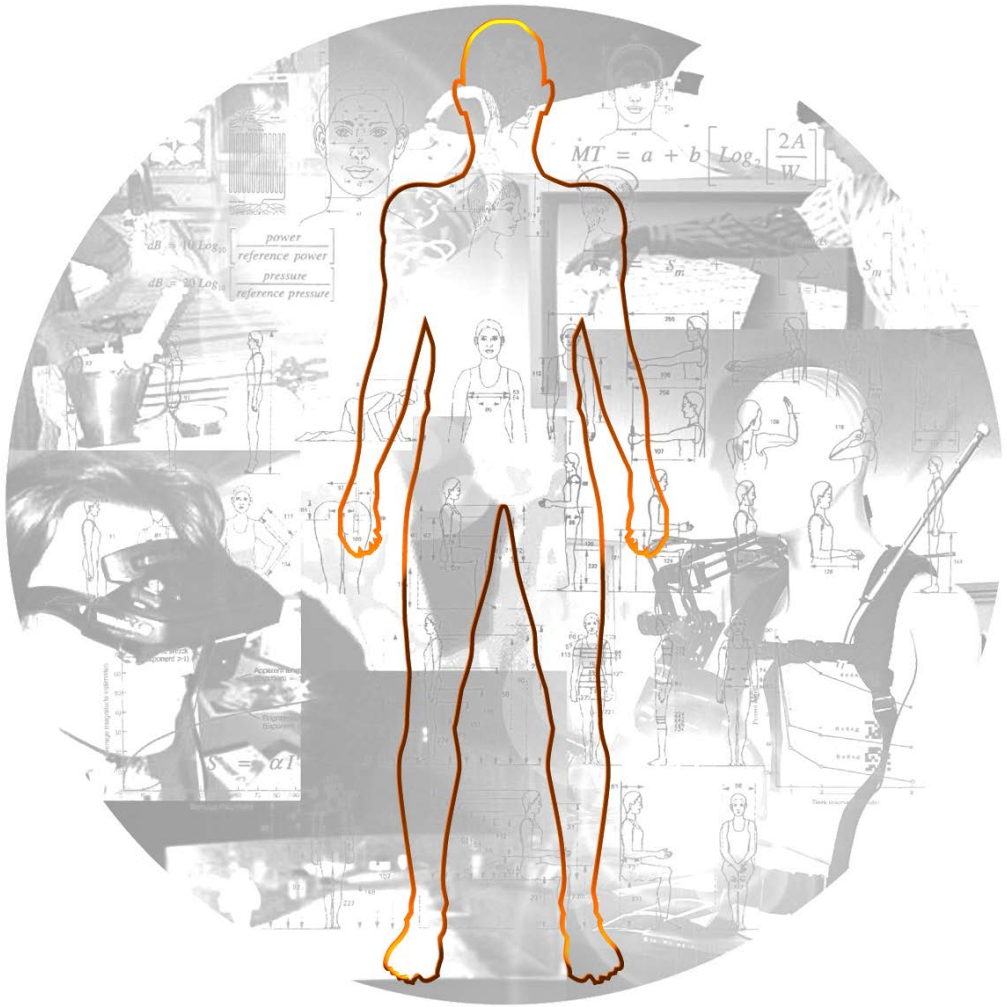
Addressing Design Challenges in Automotive UX



Prof. Joseph Giacomin

September 4th 2018

Human Centred Design



Human Centred Design

Involves techniques which empathise with, interact with, and stimulate people, achieving an understanding of their needs, desires and perspectives which often transcends that which they themselves knew and realised.

Leads to products, systems and services which are physically, perceptually, cognitively and emotionally intuitive.

Some Human Centred Design Tools

Facts Regarding Humans and Society

- Anthropometric data sets and models
- Biomechanical data sets and models
- Psychophysical data sets and models
- Cognitive data sets and models
- Emotional data sets and models
- Psychological data sets and models
- Sociological data sets and models
- Philosophical data sets and models

Capture of Meanings and Needs

Verbally based

- Ethnographic interviews
- Questionnaires
- Day-in-the-life analysis
- Cognitive task analysis
- The five whys
- Conceptual landscape
- Think aloud analysis
- Metaphor elicitation
- Be your customer
- Customer journey
- Personas
- Scenarios
- Extreme Users

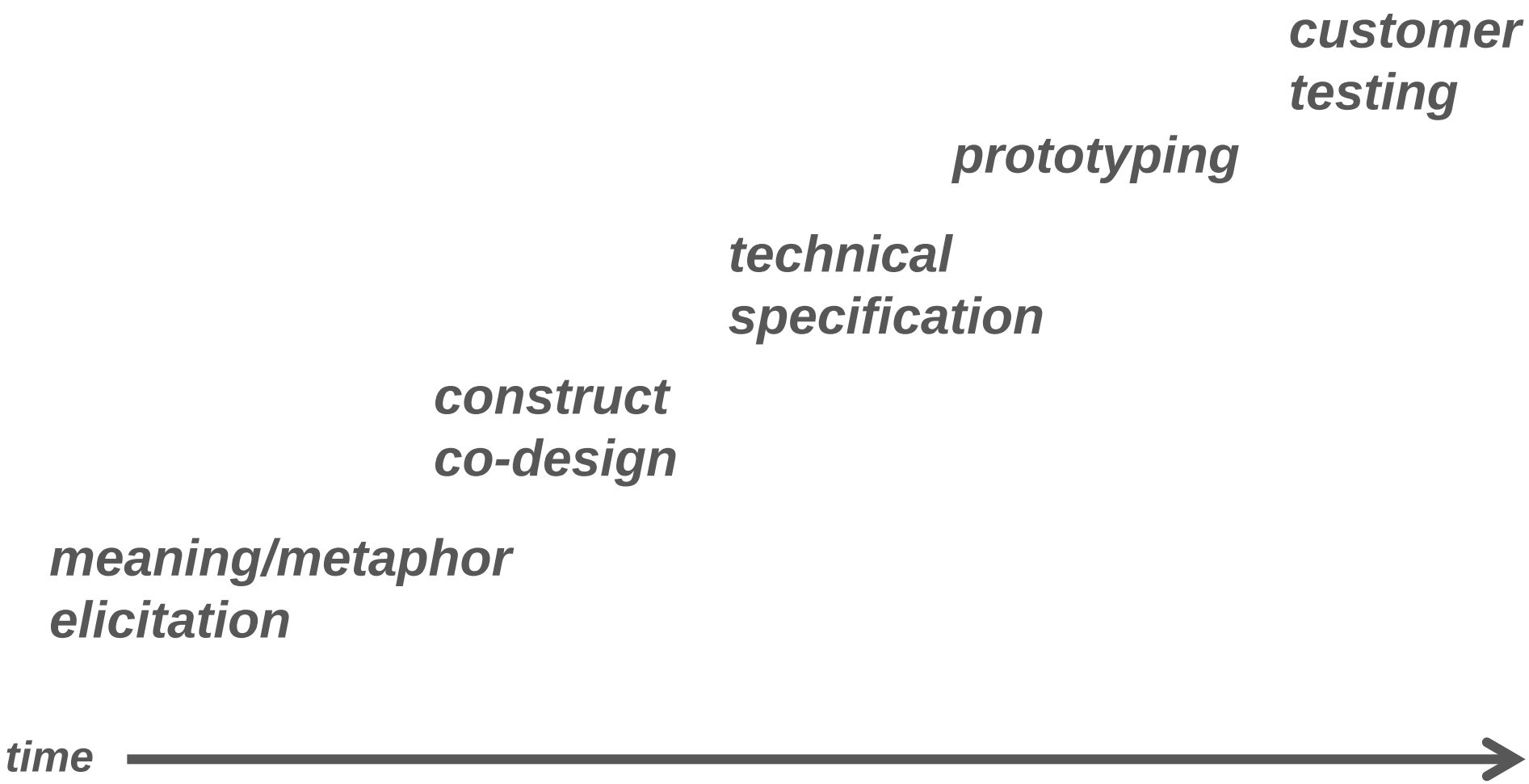
Non Verbally based

- Game playing
- Cultural Probes
- Visual journals
- Error analysis
- Fly-on-the-wall observation
- Customer Shadowing
- Body language analysis
- Facial coding analysis
- Physiological measures
- Electroencephalograms

Simulation of Possible Futures

- Role playing
- Focus groups
- Co-design
- Experience prototypes
- Para-functional prototypes
- Real fictions

Human Centred Design Process



1985

1990

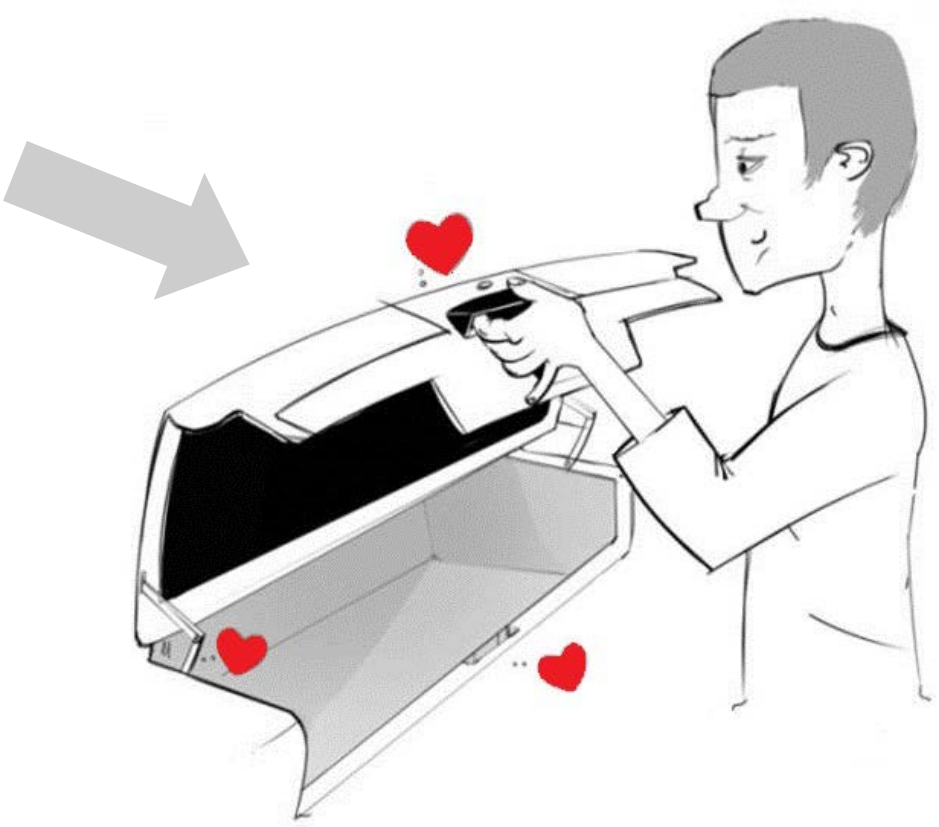
1994

ALESSI

1995

2001

The current trend is a reduced emphasis on matters of “physics”, which are now minimum requirements, and a greater emphasis on matters of “metaphysics”.



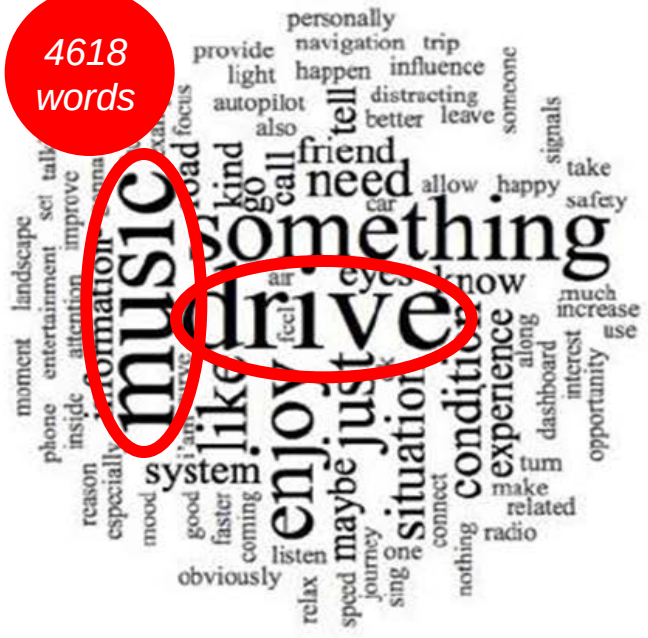
Automotive Design Challenge

Challenges Arising From The Context

Response (*n=20 participants*) to the question “what would you like now ?”

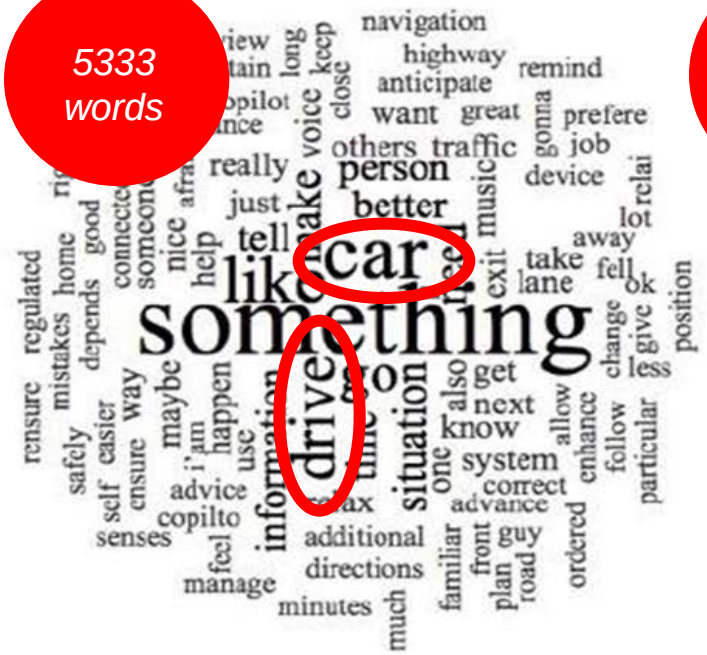
DRIVING IN THE COUNTRYSIDE

4618 words



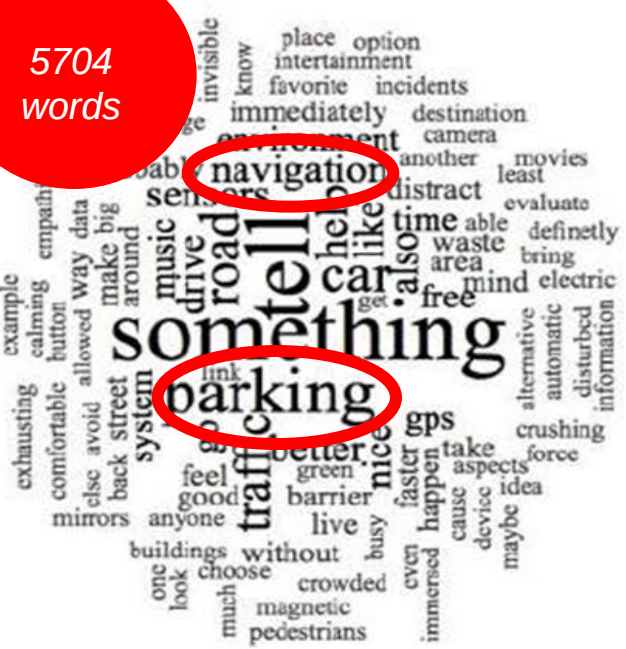
DRIVING IN THE HIGHWAY

5333 words



DRIVING IN THE CITY TRAFFIC

5704 words



Giuliano, L, Germak, C. and Giacomin, J. 2017, Effect of Driving Context On Design Dialogue, 8th Int. Conf. on Applied Human factors and Ergonomics (AHFE),17 to 21 July, Los Angeles, California, USA.

Challenges Arising From Human Nature

- role of emotion

- attention narrowing under intense emotion (Easterbrook effect)

- fading affect bias

- errors caused by encoding to, and recalling from, long term memory

- gaps caused by the event horizon

Challenges Arising From Previous Experience

When you were in a car…

Describe a time you were in a car and something happened that made you respond emotionally.

Events

Where specifically did the story happen? (i.e. motorway? country road? car park? etc.)

What did you do? (Tell us what were your actions)

Activities

What or who were involved in the story? (i.e. intelligent technology, animals or human?)

Agents

At the time of the story, you felt... (Choose as many as you like)

Emotions

Anger ● Fear ○ Disgust ● Happiness ○ Sadness ○ Surprise ○

Other ○

Challenges Arising From Previous Experience

Themes from the emotion survey (n=245 respondents):

Theme 1. Road violations (i.e. Overtaking, Insulting, Forcing to give way)

Theme 2. Car accident (i.e. Bumping into another car or obstacle, Memory of the accident)

Theme 3. External environment conditions (i.e. Heavy traffic, Road infrastructure, Other road users)

Theme 4. Infotainment (i.e. Music on the radio, News from the radio / calls)

Theme 5. Car hardware system malfunction (i.e. Warning alerts, Broken down, Partial system malfunction)

Theme 6. Abrupt manoeuvring of driver (i.e. Sudden stop, Sudden road entry, Sudden lane changing)

Theme 7. Lack of awareness in driving (i.e. Mistakes/confusion, First time driving in conditions)

Theme 8. Driving with a loved one (i.e. Driving with family, Driving with friends)

Theme 9. Generous driving behaviour on the road (i.e. Getting help, Giving way)

Theme 10. Driver’s in-car experience (i.e. Experience with car features, Feeling relaxation)

Theme 11. Car software system malfunction (i.e. Navigation/GPS error, Flat phone battery)

Theme 12. Driving landscape (i.e. Seeing incredible scenery, Night driving with stars)

Theme 13. Usability (i.e. Adjusting angels of mirrors)

Virtual Workshops: a new tool for automotive HCD

Addressing Emotion

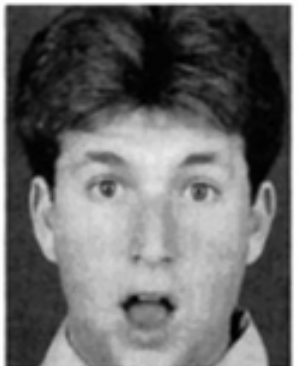
Basic Emotions

Joy

Distress

Fear

Anger

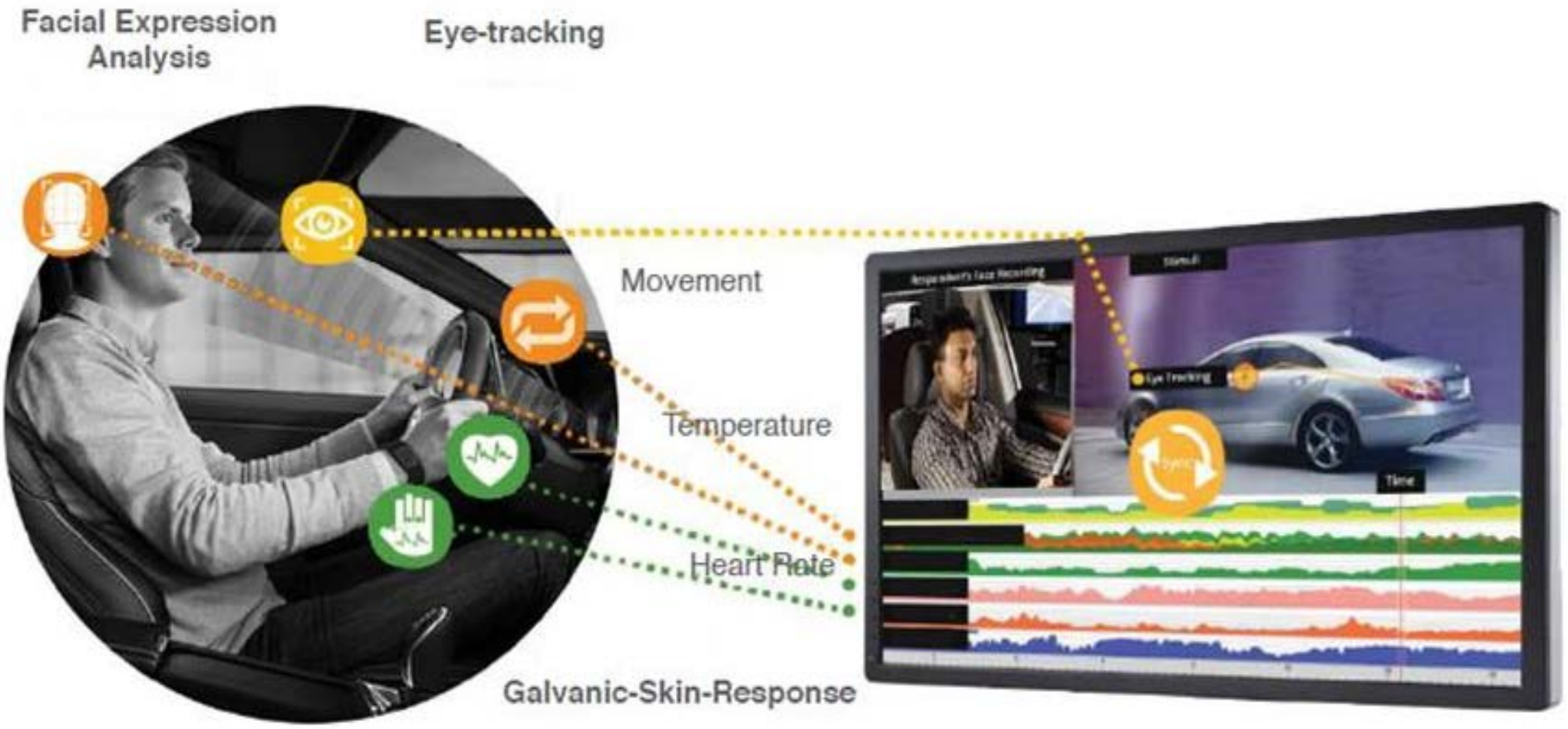


Surprise

Disgust

Ekman (1971) concluded that at least some emotions are “basic”, “universal” or “innate”. It is now generally accepted that there are at least six basic emotions which are of rapid onset and which last only a few seconds at a time.

Real-Time Emotion Measurement



Emotion
Road Circuit

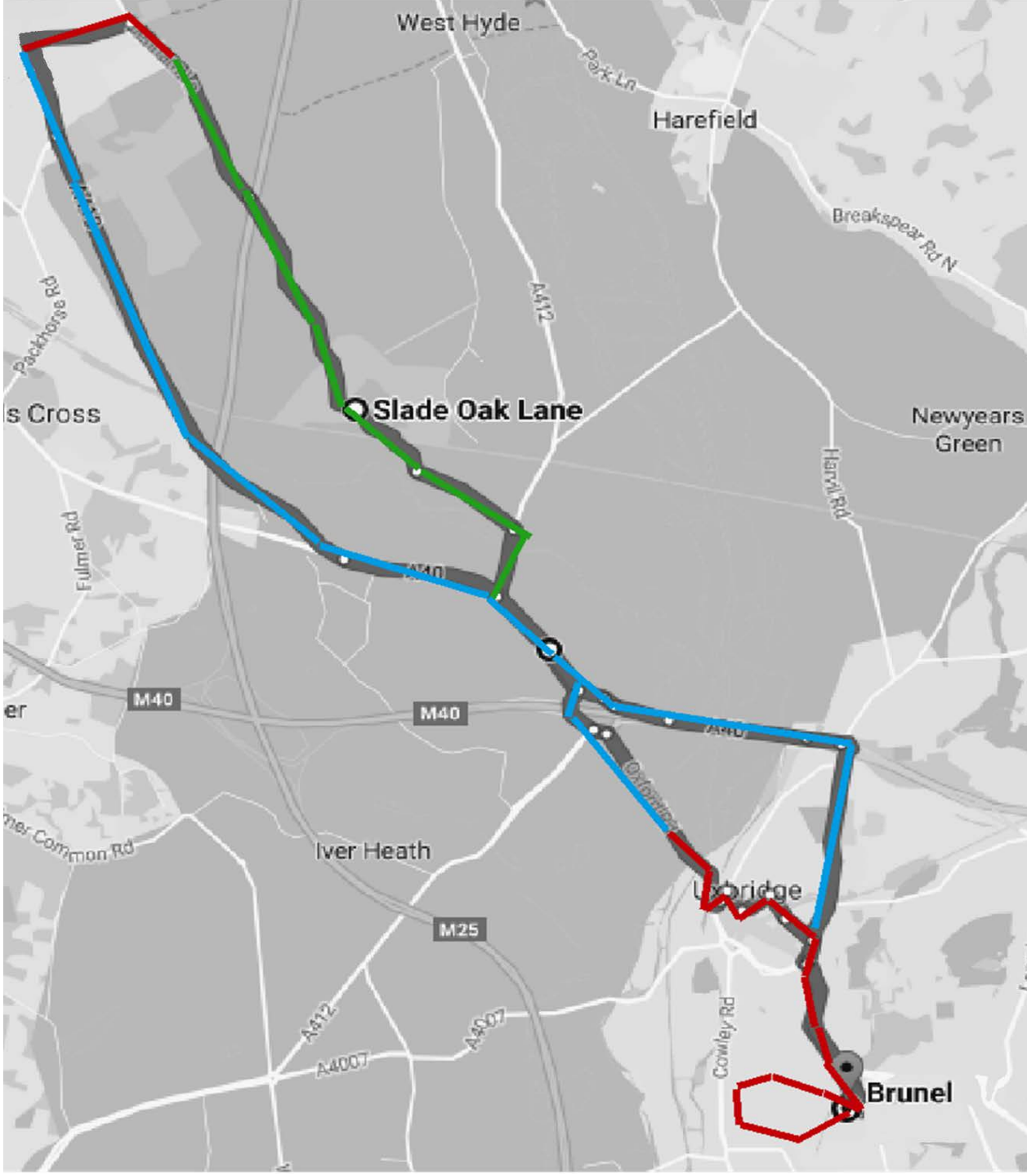
Drive time of 40 minutes

Distance of 15.2 miles

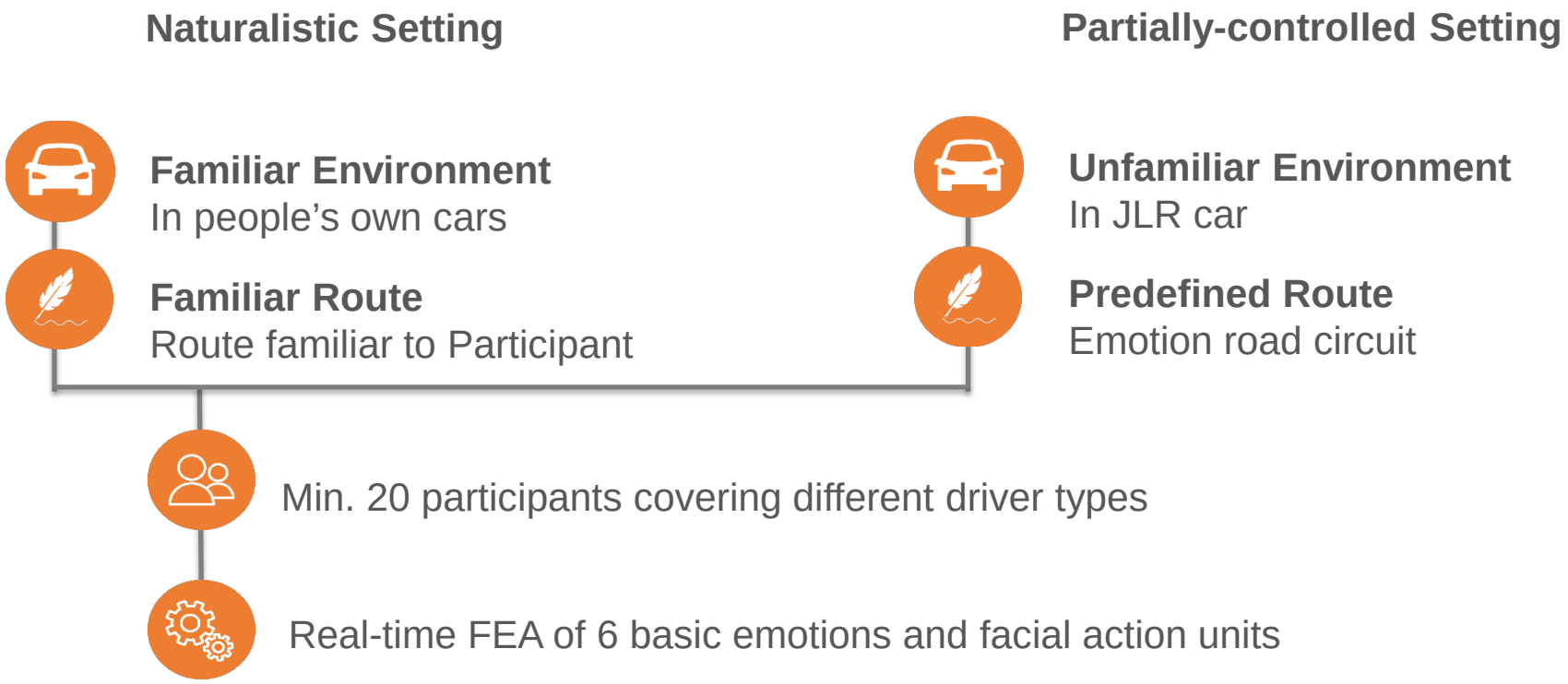
City of 4.5 miles (23%)

Country of 4 miles (26%)

Highway of 6.7 miles (44%)



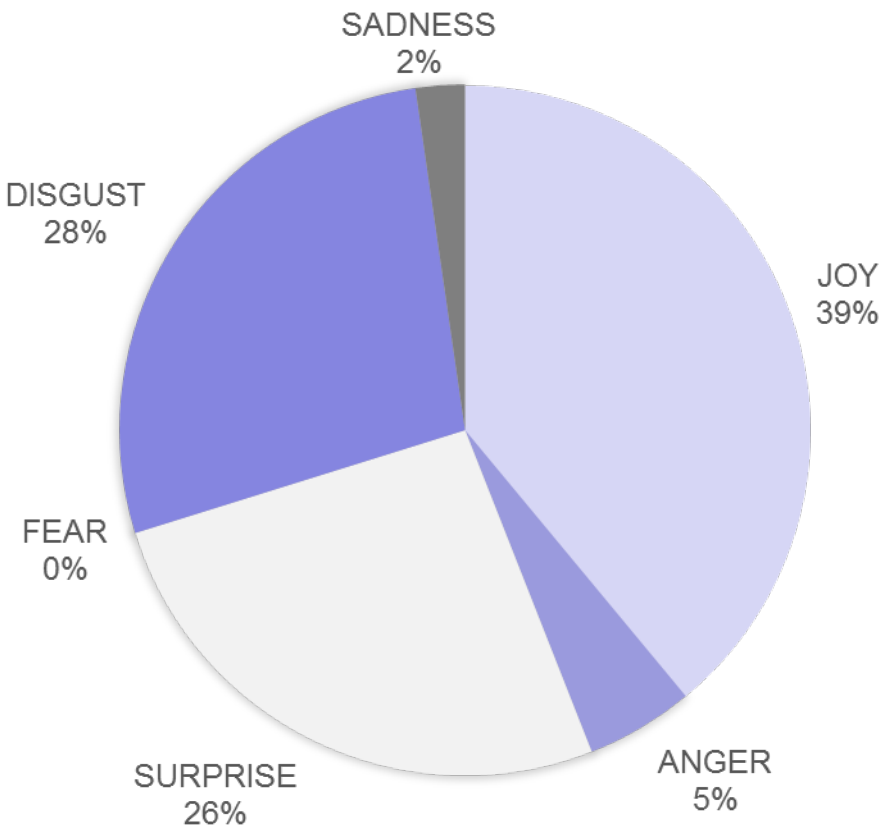
Driving Emotion Study



Driving Emotion Statistics: setting

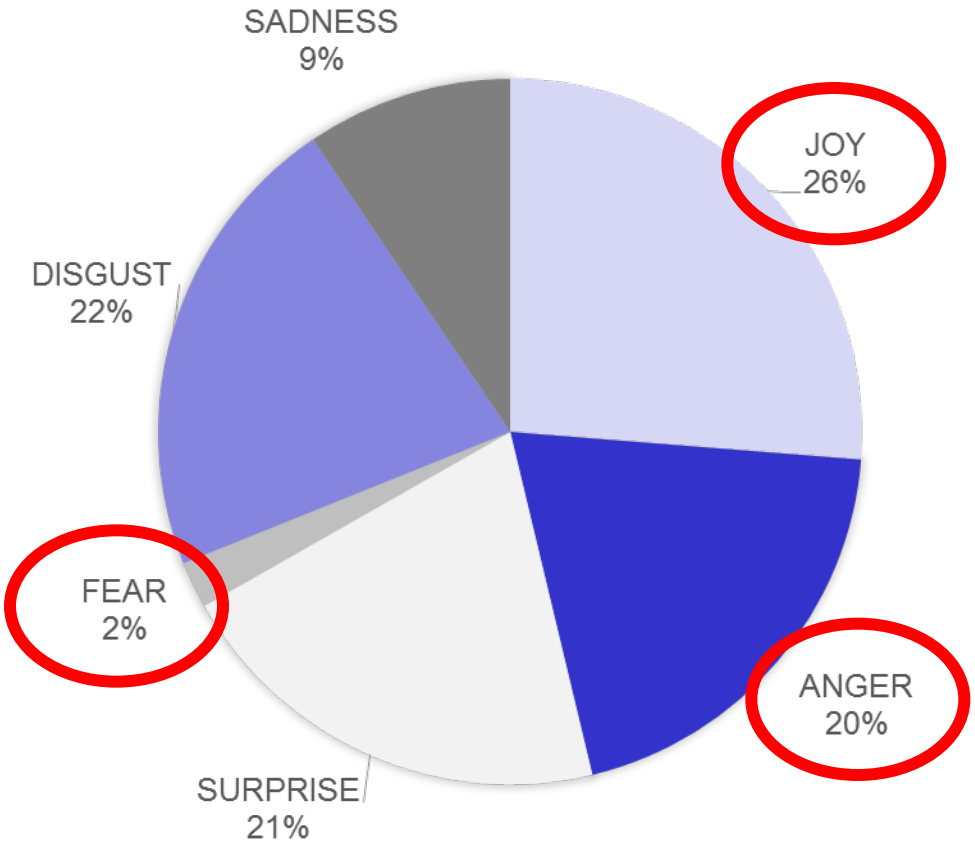
Naturalistic Setting

Average Of One Emotion Event Every 2 Minutes



Partially Controlled Setting

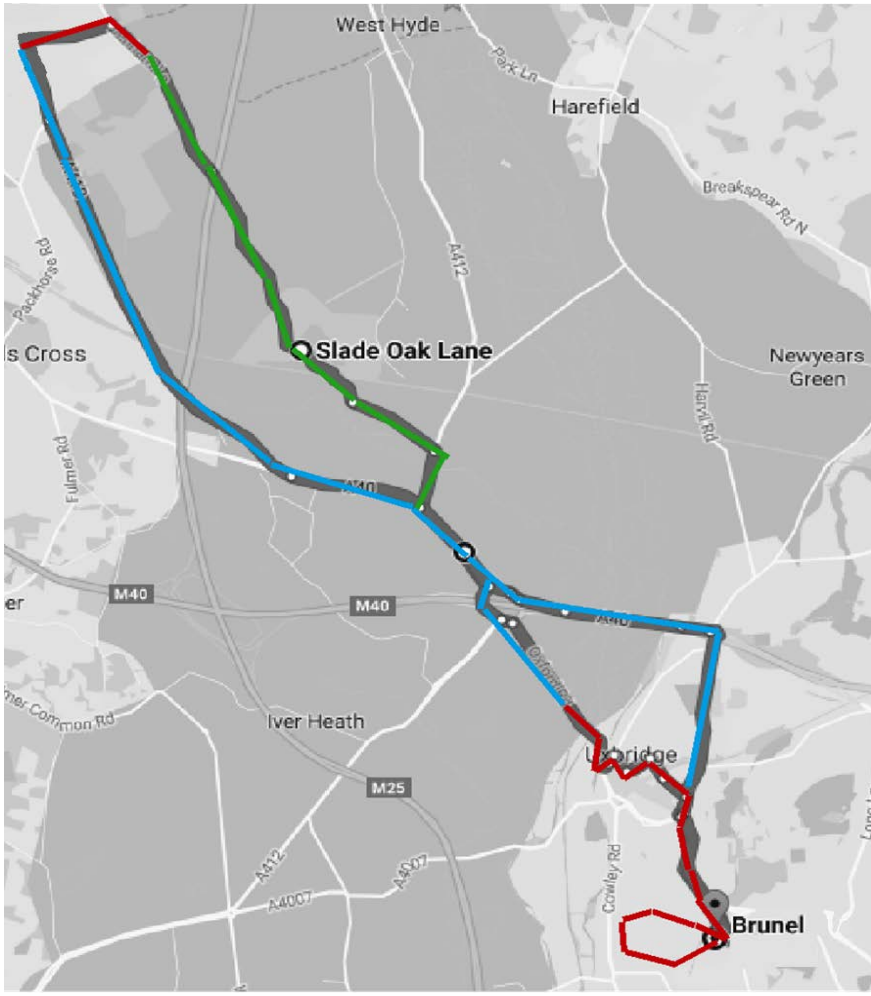
Average Of One Emotion Event Every 1.5 Minutes



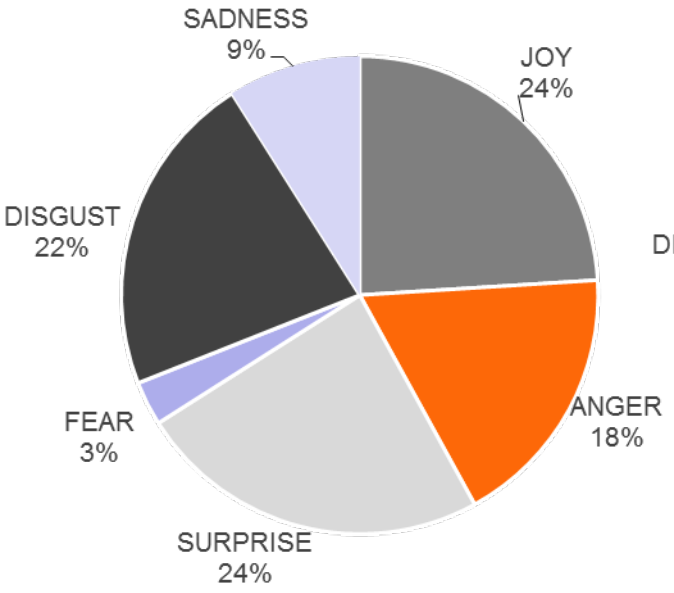
Driving Emotion Statistics: roads

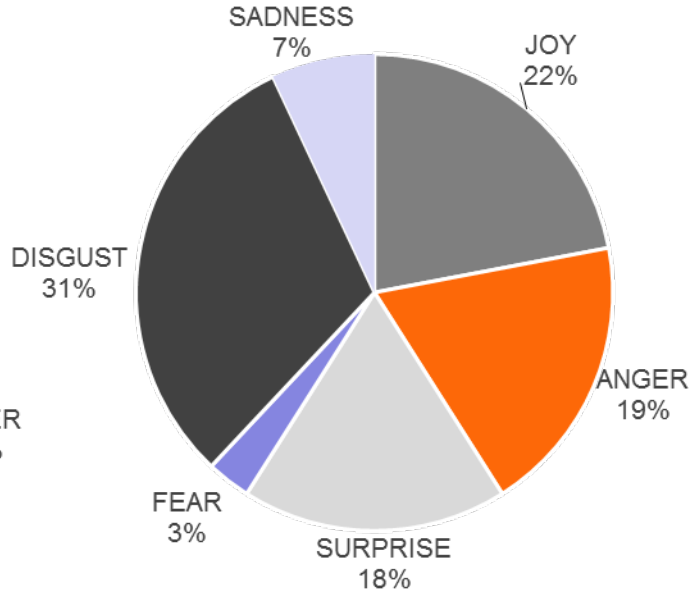
Average emotion rate for all roads was 2.16 facial expressions per minute.

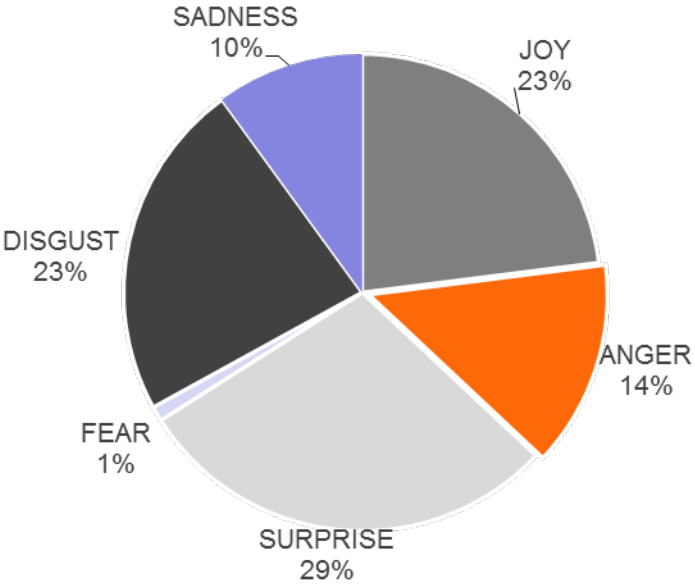
	Total Time (Sec)	Total FE	FE/Sec	Relative
Highway	16340	465	0.028	0.80
City	19163	687	0.036	1.00
Country	10273	434	0.042	1.19



Driving Emotion Statistics: causes







City

14% NAVIGATION ALERT
11% ENJOYING CAR
10% NO CAUSE ASSIGNED
7% HIGH TRAFFIC DENSITY
7% CHECKING NAVIGATION
5% INTERACTION WITH PERSON

Highway

23% CHECKING NAVIGATION
17% HIGH TRAFFIC DENSITY
6% NO CAUSE ASSIGNED
5% BAD ROAD CONDITIONS
5% ROUNDABOUT
4% NAVIGATION ALERT

Country

27% BAD ROAD CONDITIONS
13% LIMITED VISUAL FIELD
9% CHECKING NAVIGATION
4% CAR PASSING CLOSE
3% NO CAUSE ASSIGNED
3% SUN BLINDING DRIVER

Addressing Co-Design

Communication Requirements

For people in automobiles the real-time communication is effected by the screen size, screen resolution and sound volume of the in-car interface.

Tests of achievable combinations of these three parameters were thus performed in a driving simulator

Screen Options	Size (inches)	Pixels*
1	7.8 x 5.8	854 x 480
2	5.6 x 4.2	320 x 180
3	4 x 3	

*images at 25 frames per second

Speaker Options	Volume**
1	55 dB
2	67 dB
3	77 dB

**sound at driver's left ear.

Communication Requirements

For each of the nine combinations (3 screens x 3 volumes) each participant (n=24) was asked to drive in a driving simulator while performing secondary tasks:

- follow a route involving five road junctions which was presented on screen;

- detect and count the ball passes which occurred in a thirty second sports video presented on screen;

- detect and count a specific word from within a two minute speech emitted from the speaker;

Measurements were made of the cognitive workload (WL*), perceived media quality (PMQ**) and error rate (ER***) at the end of each secondary task.

The secondary tasks were repeated three times for a total driving time of approximately 45 minutes.

* Sauro, J. and Dumas, J.S. 2009, Comparison of three one-question, post-task usability questionnaires, Proceedings Of The SIGCHI Conference On Human Factors In Computing Systems, ACM, April 4th to 9th, Boston, Massachusetts, USA, pp. 1599-1608.

** International Telecommunication Union, 1999, ITU-T Recommendation P.910, Subjective video quality assessment methods for multimedia applications, Series P Telephone Transmission Quality, Telephone Installations, Local Line Networks.

***Rümelin, S. and Butz, A. 2013, How to make large touch screens usable while driving, Proceedings of the 5th International Conference on Automotive User Interfaces and Interactive Vehicular Applications (AutomotiveUI13), ACM, October 28th to 30th, Eindhoven, The Netherlands, pp. 48-55.

The optimal combination was:

- screen size: 7.8 x 5.8 inches
- frame resolution: 854 x 480 pixels
- speaker volume: 77 dB

Telepresence Requirements

Participants (n=24) were grouped into couples with one person assigned the role of driver and the other the role of collaborator. The driver was located in the driving simulator while the collaborator was located in a control room.

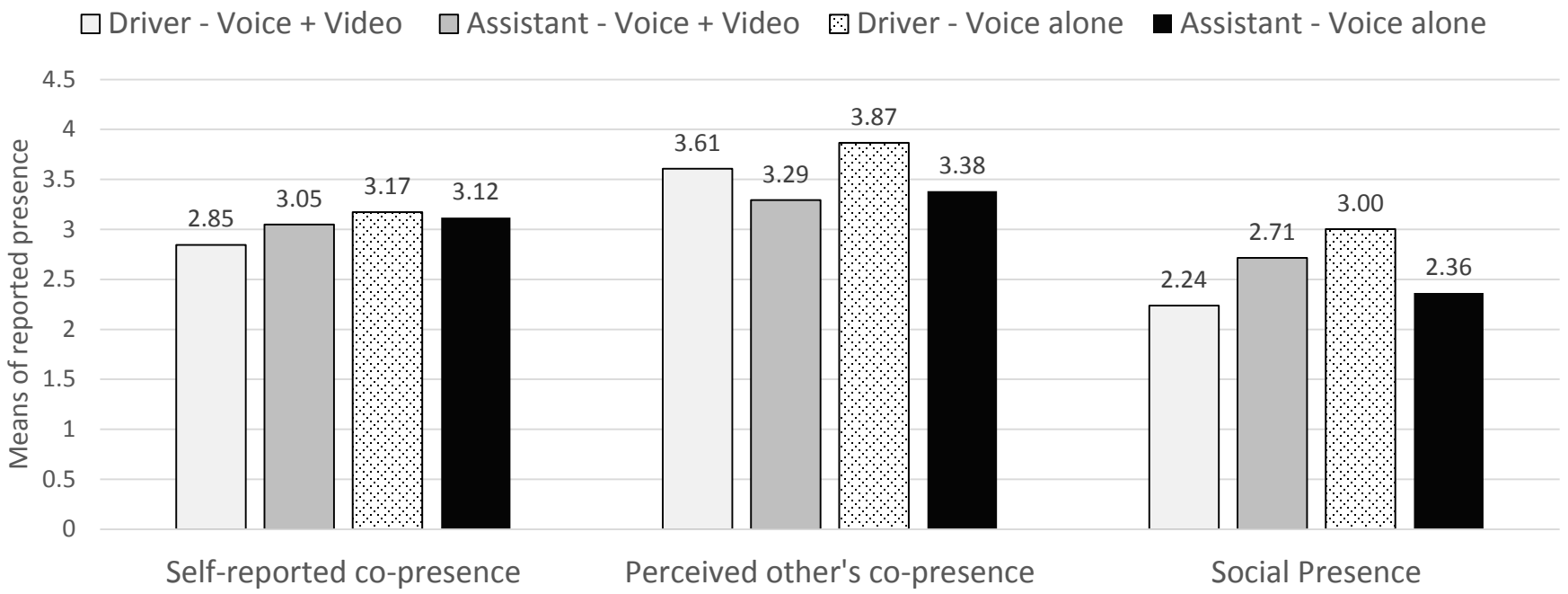
Each couple was connected through either a **voice+video** channel or by a **voice channel** alone, and was asked to perform tasks as a team while driving a city route:

- co-navigation task where both driver and collaborator had a map (10 minutes);
- co-navigation task where only the collaborator had a map (10 minutes);
- riddle resolution task where the couple talked their way through a problem of logic (10 minutes)

Self-reported copresence, reported others copresence and social presence* were measured at the end of each task.

* Nowak, K.L. and Biocca, F. 2003, The effect of the agency and anthropomorphism on users' sense of telepresence, copresence, and social presence in virtual environments, Presence: Teleoperators & Virtual Environments, Vol. 12, No. 5, pp.481-494.

Telepresence Requirements



Greater telepresence was reported in the case of the voice channel alone.

Co-Design Requirements: general

Open Questions -> to stimulate creative responses

Narrow Questions -> to ground responses via a predetermined experience or concept

Experience Questions -> to ground responses via past experiences of the individual

Descriptive Questions -> to solicit longer and more detailed articulations

Co-Creation Questions -> to facilitate brainstorming

Co-Design Requirements: specific automotive

	Discussion Context			Discussion Target			Discussion Rhetoric				Discussion Objective	
	Road And Traffic Conditions	Interaction With The Vehicle Or With Other Agents	Unexpected Events, Errors Or Emergencies	Component	System	Complete Vehicle	Where	When	How	Why	Incremental Innovation	Disruptive Innovation
Q1												
Q2												
Q3												
. . .												
Qn												

Automotive Habitat Laboratory

Virtual Workshops: a new tool for automotive HCD

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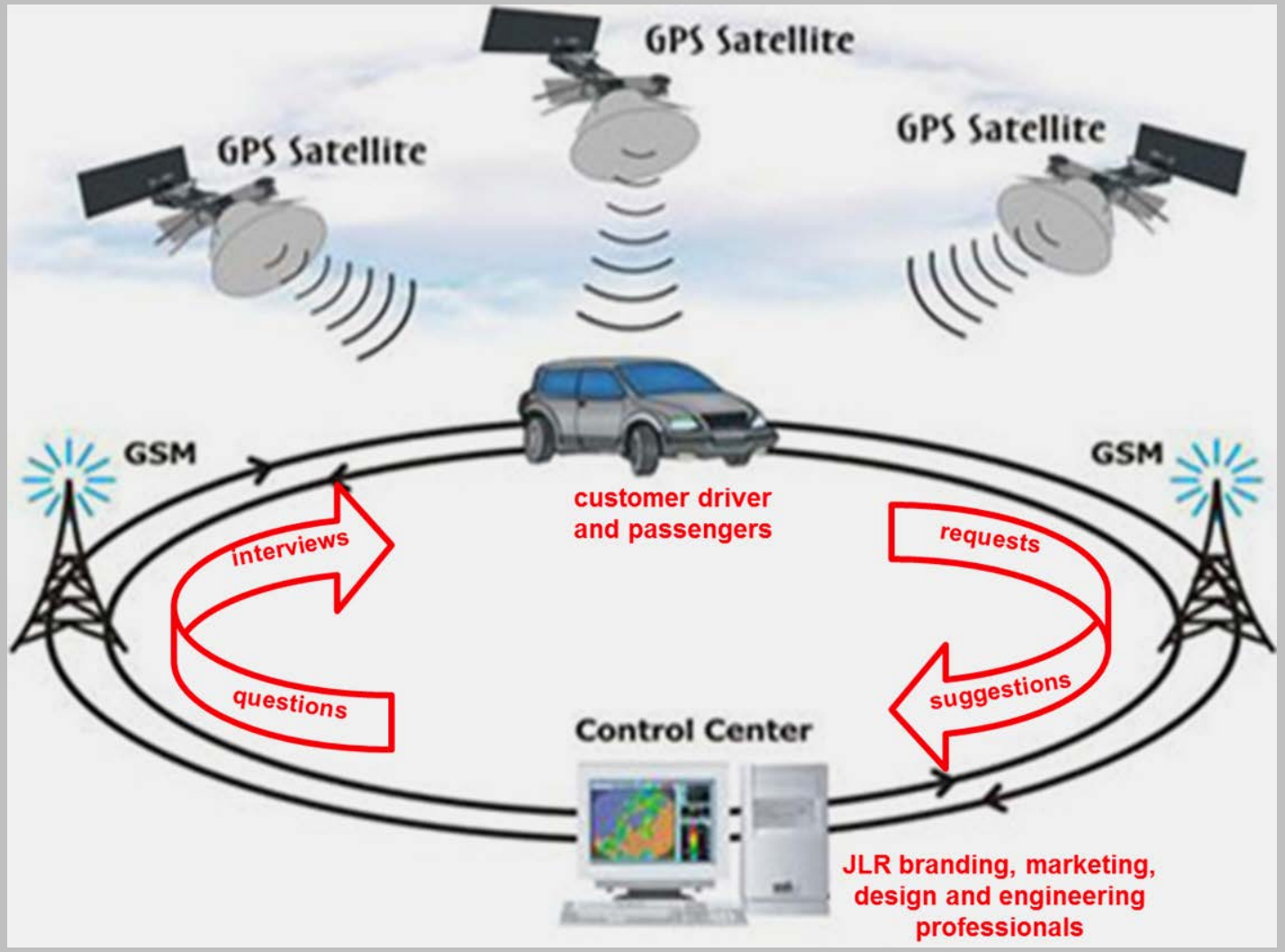
LAND ROVER

HCDI™ Human Centred Design Institute



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Cameras

Driver camera
iMotions camera
Interior camera
Dashboard camera

Three Raspberry Pis

CAN bus outputs via USB to the Raspberry Pis, which transfer the data to the communications laptop via an IP network.

Modem

Streams data live back to the control room.

Microsoft Surface

behind driver's seat controls all software, including iMotions.

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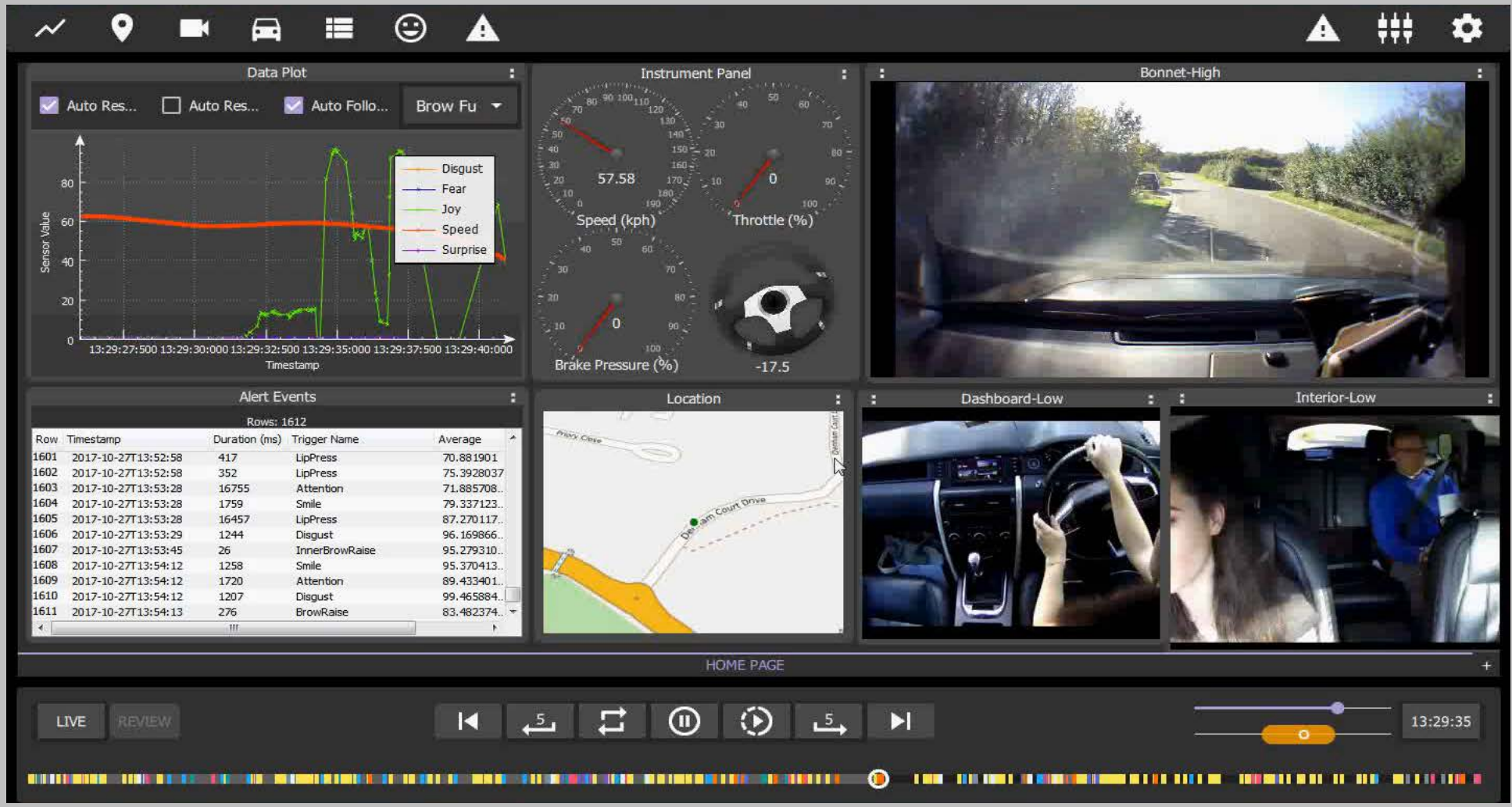


Looking To The Future

Human Centred Design Of Autonomous Vehicles

Vehicle Concept Metaphors and Architectures

Communication with Occupants and Road Users

Vehicle Emotion Management Systems

Trust Strategies and Brand Strategies

Ethical Design Framework

Customer Acceptance Tests

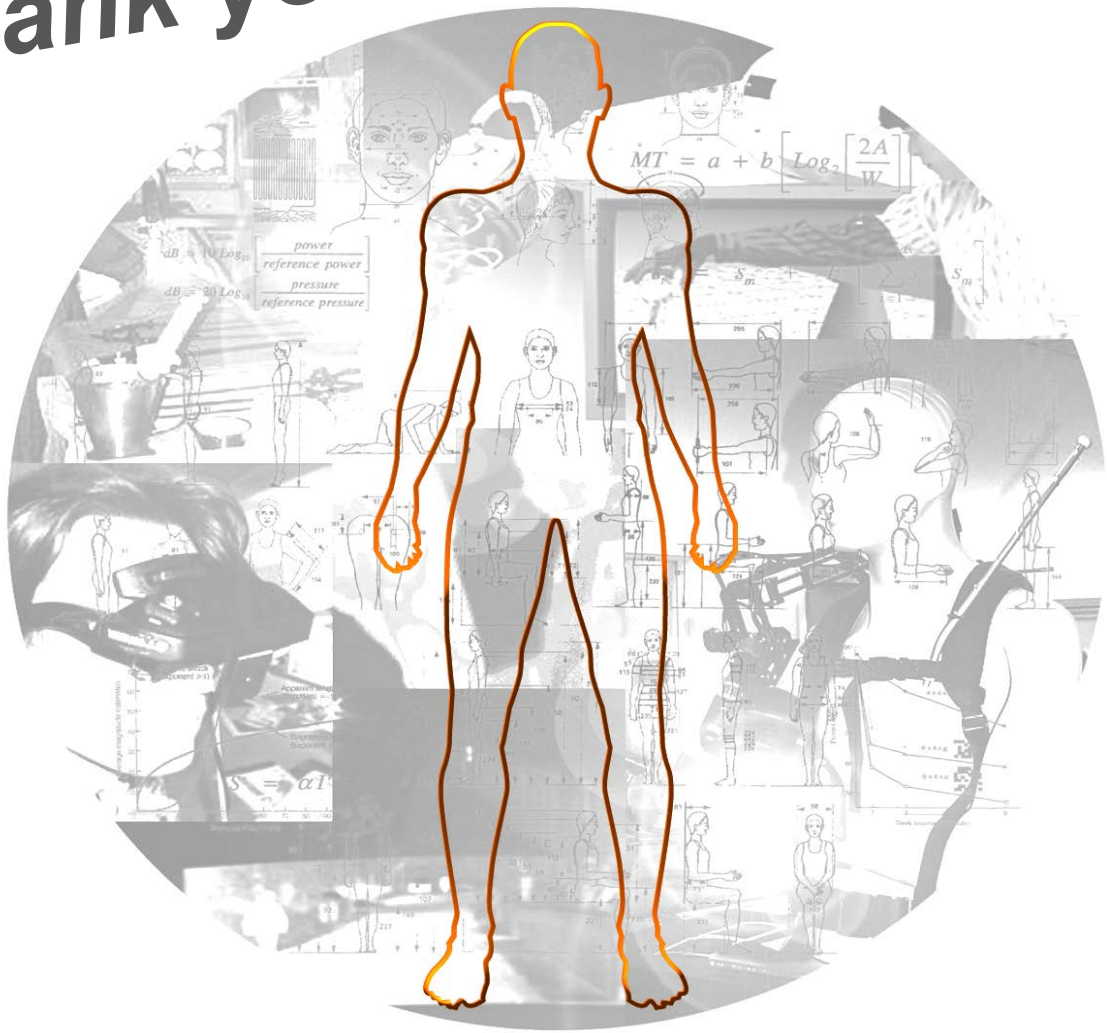
Inclusivity and Disabled Mobility

Traffic Management Systems

Infrastructure and Urban Planning for Autonomy

Co-design Frameworks

Thank you.


$MT = a + b \left[Log_2 \left[\frac{2A}{W} \right] \right]$
$dB = 10 Log_{10} \frac{power}{reference\ power}$
$dB = 20 Log_{10} \frac{pressure}{reference\ pressure}$