

DRS2020
BRISBANE, 11–14 AUG
SYNERGY



Process matters: from car owner experiences to automotive design proposals

Jiayu Wu*, Dale Harrow, Katrine Hesseldahl, Samuel Johnson, Sheila Clark, Daniel Quinlan

Intelligent Mobility Design Centre, Royal College of Art

*Corresponding author e-mail: jiayu.wu@rca.ac.uk

doi: <https://doi.org/10.21606/drs.2020.167>

Abstract: Collecting and analysing user experiences, communicating discovered patterns, translating information into design proposals and materialising designed features is central to design driven research. This process immerses design teams into all aspects of users' experiences, helping them empathise with and scrutinise every detail until designers own the experiences and produce design proposals addressing end users' needs in unique ways leading to disruptive innovation. Design practice's strength is crystallising solutions into visualised and interactive proposals, presenting in-depth details of the look, feel and emotions they stimulate, and assisting decision making in product, service and business innovations. Existing research focusses on early stage collection of lived user experiences and final visualisation of the design proposal, yet seems to miss detailed discussion of the core bridging of user experiences and precise design proposals. We describe optimising a process supporting designers continuously switching between gathering user experiences and industry/market contexts when generating automotive design proposals.

Keywords: Experience study; Design research process; Design process; automotive design proposals

1. Introduction

User experience studies have been used by Human Computer Interaction (HCI) and product designers for decades and are at the core of design research. Most publications addressing experience focus on defining experience (Dewey, 1980; Forlizzi & Ford, 2000; Forlizzi & Battarbee, 2004), framing the experience process (Karapanos et al., 2009), prototyping experiences in innovation processes (Buchenau & Suri, 2000), methods for collecting experience data (Gaver et al., 1999; Wu, 2012) and discussing evaluation (Vermeeren et al., 2010). However, addressing how to plan and refine a research process which allows designers to step in and out of the experience data while making the transition from data to design proposal seems to be missing. User experience research can point to cases describing



This work is licensed under a [Creative Commons Attribution-NonCommercial 4.0 International License](https://creativecommons.org/licenses/by-nc/4.0/).

how to collect user insights and lived experiences (Dow et al., 2016; Gaver et al., 1999; Bichard et al., 2015; Wilson & Tewdwr-Jones, 2019). However, few researchers illustrate the process of transforming analysed experience data into design proposals, especially how designers act when processing experience data and implementing their own interpretations as design proposals at each research stage. Some studies address similar questions, for example, discussing designer's emotions and actions elicited during the design process (Biagioli et al., 2018) and reviewing the literature describing how experience data can inspire, interpret and explain when generating conclusions for art and design research (Koskinen & Lee, 2009). Neither articulate design research processes that facilitate the conversion of experience data into conclusions. This paper presents an automotive research project seeking new design spaces for vehicle owners, dissecting the research steps designers used to empathise with individual experiences to create vehicle service proposals. We show the value of combining design driven visualisation and empathy (Koskinen et al., 2003) in an iterative process addressing end users and clients, delivering proposals at different levels. The main objective is to illustrate a research process where distinct research activities are used including gathering and analysing car owners' experiences, investigating business processes, and collecting insights from the client, which are then used to visualise design proposals.

1.1 User experience study: from data collection and analysis to design proposals

HCI user experience study has significant momentum but is criticised for being vague, elusive and ephemeral (Hassenzahl & Tractinsky, 2006), mainly because of the focus on inventing methods of collecting and analysing data. Examples include introducing software to gather lived experiences (Dow et al., 2016; Wilson & Tewdwr-Jones, 2019), centring user experience as a usability test tool (Vermeeren et al., 2010; Tullis & Albert, 2013), searching behavioural patterns for designing interactive products (Forlizzi & Ford, 2000; Forlizzi & Battarbee, 2004; Suh & Chang, 2006) and addressing user's non-instrumental needs in fragmented empirical research (Garcia & Hammond, 2016; Xu, 2012). Design driven user experience study takes a different approach, dissecting designers' thinking and empathic processes in product ideation (Kouprie & Visser, 2009; Visser et al., 2005), transferring user experiences into product prototyping origins (Buchenau & Suri, 2000) and considering different levels of cognitive reflections triggered by design (Desmet & Hekkert, 2007; Norman, 2005). The literature discusses designers stepping into users' experiences to gain knowledge valuable in the creation process and then stepping out to generate proposals. Design proposals are presented and discussed in design research project articles ranging from sketches to semi-finished prototypes to demos to final products (Buchenau & Suri, 2000; Bichard, 2015; Orth & Thurgood, 2018). Designers are involved in an iterative research process including observing users, generating design briefs (a design proposal 'lite'), repeating observations in more depth, visualising design proposals, user testing and finalising design proposals. Design proposals at different stages act as essential tools assisting with verification of designers' understanding of user experiences and should not only appear at the end of a research

project but throughout the entire research process. Design proposals should also serve as a part of the research process to incorporate new emerged insights. The value of generating these interim design proposals to demonstrate and visualise possible outcomes to users while collecting and analysing experience data has not been fully addressed.

1.2 User experience studies for vehicle design and services

This decade, user-vehicle interaction and experience design has been brought to the forefront of innovation in the automobile industry, mainly focusing on new mobility technologies and use cases. Several areas particularly attract research attention: autonomous vehicle design and enabling technologies, in-vehicle infotainment systems and user experience studies, and user interfaces for vehicles and connected devices. Mobility-as-a-Service (MaaS) has gained significant attention with great potential for service innovation integration with personal device applications and Vehicle-to-Everything (V2X) platforms. This trend opens research opportunities around individual vehicle user experiences and vehicle usage behavioural patterns for extended services and applications. Automotive concept design and research incorporates typical user experience studies for product design (Pettersson, 2017), envisioning future trends and design opportunities for technology innovation, typically with an emphasis on high end applications user experience. The following case study discusses how addressing common car owners' conundrums can result in relevant service solutions.

2. Case study – from vehicle user experiences to design proposals

Our vehicle experience study and design provide empirical examples for the design research community, looking at the research process from capturing existing user experiences to implementation of solution designs. We breakdown the research process into steps and analyse the methods, organisation and effectiveness.

2.1 Project introduction

Motoring Makeovers explores design opportunities for providing car owners with aftersales services to encourage keeping their beloved cars for longer. The aim is to investigate typical user behaviour when shopping for, maintaining and recycling private cars to explore alternative vehicle service designs. The design assumption is that if people want to change their cars years after purchase there must be motivations behind their decisions, partially because of desire for new things and partially due to marketing strategies encouraging purchasing new cars. This phenomenon is neither environmentally sustainable nor necessarily the best brand loyalty strategy for automotive companies.

We explored car ownership user experiences including defining scenarios such as getting to know the car, keeping it clean, personalising the interior, and sharing the vehicle with other family members. The team interviewed car owners to get to know them and their lifestyles, invited their participation in empathy workshops to recollect their habits and behaviours,

and conducted journey shadowing to observe their car use. The team also interviewed the client, an international automotive company, to ascertain its current vehicle sales and market position and identify potential near-term challenges, touring car showrooms to experience and investigate current approaches for selling products and services. These activities helped the designers develop their understanding of car ownership and immerse themselves in car owners' world. The experience data was analysed and transferred into ideas for designs for alternative car ownership products.

2.2 Research process and challenges

We follow our standard design and research process synthesised from the British Design Council's Double Diamond process (Design Council UK, 2005), the d. school's design thinking process (Institute of Design at Stanford, 2010) and Rampino's design driven innovation process (Rampino, 2011):

The British Design Council defines a typical design process as:

1. Discover: begins with an initial idea or inspiration based on identified user needs
2. Define: interpretation and alignment of these needs with business objectives
3. Develop: design-led solutions are developed, iterated and tested
4. Deliver: resulting product or service is finalised, approved and launched

d. school breaks down the five stages of the design thinking process as:

1. Empathise: gain empathic understanding of users within the context of the design challenge
2. Define: specify key problems users face based on analysis of user observations
3. Ideate: idea generation process encouraging 'going wide' in terms of concepts
4. Prototype: produce many inexpensive, scaled-down versions of products or features so users can walk through scenarios
5. Test: solicit feedback about prototypes created by target users and have another opportunity to gain empathy for the people the product is designed for

Rampino's design driven innovation process includes:

1. Idea creation: identify user challenges and define research problems
2. Idea selection: analyse user data and shape design hypothesis
3. Development: create design proposals and narrow down to deliver prototypes
4. Marketing: test prototypes with users, define appropriate marketing strategies

Our research process was structured as:

1. Definition: define research aims based on designers' initial understanding and experience data collection from users
2. Creation: construct scenarios where users and contexts are represented and create ideas for further design proposals

3. Iteration: refine design proposals by testing scenarios with users walking through created solutions
4. Proposition: decide design proposal methods and implement concepts as tangible deliverables

There were challenges in almost every step for the team when identifying the most valuable experience data and translating it into tangible design proposals including:

- How to make judgements about which scenarios include valuable experience data that will lead to novel design opportunities
- How much experience data will be enough and what types of data are effective for making decisions about design proposals
- What types of design proposal appropriately reflect true user experiences

2.3 Research phases: translating experiences into design proposals

A picture of how design concepts were generated from investigations of user experiences is seen as we progress through our four research phases.

1. Definition

This phase defined and explored key car ownership scenarios. Research methods included car owner telephone interviews, empathy workshops, journey shadowing and automotive client telephone interviews. Objectives when selecting research methods were:

- to go from basic to in-depth user experience investigation to help designers discover hidden users' needs at different levels
- combine text and visual summaries when organising collected experience data to ensure that the logic and intentions behind user behaviours drove initiation of design proposals

Telephone interviews were used for initial insights into individual car ownership. Fifteen people (six females and nine males) participated in twenty-minute interviews with questions including:

- How long have you had your car?
- When did you feel like you had built a relationship with your car?
- Do you have a name for your car?
- Can you tell us a story about your car and you?
- How do you see the relationship between you and your car?

Telephone interviews (Table 1) indicated that most people see their cars as an important friend, somebody they can rely on - one participant mentioned "he is like my rock". One participant said she built a relationship with her car once it stopped breaking down. She realised that once she learnt how it works, she started building trust between her and the car. Several male participants claimed they love the components of their cars and working on them - they enjoy the "machinery relationship". Most people said looking after their

vehicles is important to them. One person mentioned having to change their car because of a new child but they preferred their old car from a driver’s perspective. A few people also saw their cars as tools, practical objects, and therefore felt they had a responsibility to look after them and ensure they function correctly.

Table 1 Telephone interview findings: initial understanding

Initial understanding	Key words
Vehicle user relationship	Friend; Reliable object; Tool
Moment of relationship build up	The car stopped breaking down; Learning how the car functions
What is important in the vehicle user relationship	Looking after the car; A good fit with the family

Empathy workshops were conducted to collect and investigate key car ownership scenarios. Five car owners (two males and three females) participated in the workshops, recounting a story about a journey with their car. They were asked to recall the journey and document it step-by-step using a Ritual Journey Map based on typical Journey Mapping tools. Ritual links repeated actions or habits during car journeys to the meaning of the relationship with their car. Participants were then asked to roleplay their journeys using cardboard props representing items they take with them or habitually keep in their cars such as mobile phones and amulets. Participants were asked to describe any key moments when they interacted with their cars and why these moments had significance for them.

During the workshops three major topics related to car ownership appeared (Table 2):

- car maintenance including cleanliness, tidiness and digital updates
- family needs when sharing a vehicle and journey
- personal vehicle settings and adaptations

We collected examples of experiences for each topic, documented with participant quotes.

Designers summarised their understanding based on the user experiences to create an initial design proposal. The proposal addressed ownership experiences that appeared repeatedly such as:

- seeing “looking after the car” as important, as it strongly impacts their driving experience and sense of belonging to the car
- having new family needs requiring that they either change the car or create a new way of using the current cars functions to address the needs
- people (especially men) had a strong desire to upgrade their car’s technical functions

We therefore proposed an aftersales service allowing owners to upgrade their car components and functions.

Table 2 Empathy workshop findings: Summary of ownership topics with user quotes

Ownership topic	Supporting examples
Car maintenance	One owner mentioned ensuring his car is clean, tidy and equipped gives him a sense of pride, happiness and confidence that his vehicle will perform well. "I feel like the car is a part of my family. I enjoy the ride more when the car is clean."
Family needs	A mother described her daily routine when driving her daughter to nursery and their different preferences for playing podcasts. "I always wait listening to the podcast after I dropped my daughter off. It is time for me to reflect or switch off."
Personal vehicle settings	One driver described commuting habits and their connection with maintaining his car: he always cleans windscreen and side mirrors before switching on satellite navigation and dashcam before setting off. "I am a part time police officer so that is why I know how to check everything. We have a checklist for all the things need to be checked such as lights, miles, etc."

After initially understanding car ownership behaviours, we decided to interview our international automotive company research sponsor to gather insights about mobility trends and their impact on aftersales services. We interviewed the aftersales and marketing departments by telephone, asking about the core business of the aftersales market, aftersales and marketing strategies, and perceived future mobility trends challenges.

We learnt that the company's core European aftersales business is limited to dealership experiences - selling accessories, showroom design consultations and explaining offers to individual customers. Vehicle customisation and long-term customer loyalty still offer substantial opportunities for business innovation. Participants mentioned that aftersales service will face significant challenges once electric vehicles are a substantial proportion of the market as they need less maintenance resulting in an estimated fifty percent reduction in sales of car parts.

We discussed our initial thinking about designing a vehicle upgrade subscription service allowing users to change car components and accessories. They were very interested in supporting the idea by involving their customer community, encouraging user driven customisation, and providing fun activities to reinforce brand loyalty. This design direction potentially addresses the electrification challenge, providing additional sources of revenue (Table 3).

Table 3 Client interview summary: proof of initial idea

Challenge	Potential for innovation	Value of innovation	Initial design hypothesis
Limited aftersales services	Increase provision of alternative services such as part customisation, accessory designs, customer events	Reinforce brand loyalty, boost aftersales income	Design vehicle upgrade service providing parts, accessories and digital updates
Electric vehicles require less aftersales service			

Journey shadowing strengthened our understanding of our participants experiences owning and using cars, habits accumulated over years of experience, and expectations about what can be changed and what they wish to stay the same. Insights about buying a new car, current car likes and dislikes, and experiences with car maintenance were collected during the journey. To investigate a range of ownership scenarios, we needed regular drivers in different stages of relationships with their cars, for example, drivers who use the same car for years, users of family cars, and new car users. Four users had their daily commute journey shadowed. We observed drivers' behaviour and the implications of their relationships with their cars, the findings (Table 4) supporting the next phases ideation process.

Table 4 Journey shadowing findings

Topic	Users habits/behaviours/expectations	Value of design provision
Maintenance service	Always go to same car dealer; New owners worry about being cheated, need reassurance about where they can safely go	Trust the quality and pricing of the service
New car purchase	Every 3-4 years consider buying a new car; When buying a new car consider depreciation, technology upgrades, interior materials, whether it is suitable for life changes and trying something new	Keep the value of car for longer
Upgrades to consider for current car	Technology related items such as satnav, headlights, cruise control, dashboard, media player, etc.; exterior design; interior materials such as seating and steering wheel	Easy to replace or upgrade
Parts owner feels close connections with	Steering wheel; In-car mirrors	Keep the original function and customise the styling

2. Creation

The research team now has a clear understanding about topics that car owners and service providers focus on. A design hypothesis has emerged from the first phase of car ownership experience investigations. “Good facts are only the starting point, good product design is actually built on the designers’ interpretation of those facts.” (Holtzblatt, 2016) Based on the design hypothesis, we conducted an ideation workshop looking at the experience data, emerging trends in mobility, and current vehicle sales models (Figure 1) to create visual design proposals that people could look at, feel, judge and provide feedback. The main objectives when selecting research methods in this phase are:

- ensure designers are exposed to richly detailed experience data summarised from the *Definition* phase before and during the ideation process
- ensure designers’ ideation is guided by the ethical, societal and technological status quo as well as the commercialisation environment

The current model for choosing the specification of your car happens in three stages. Pre purchase, In vehicle set up and after market.

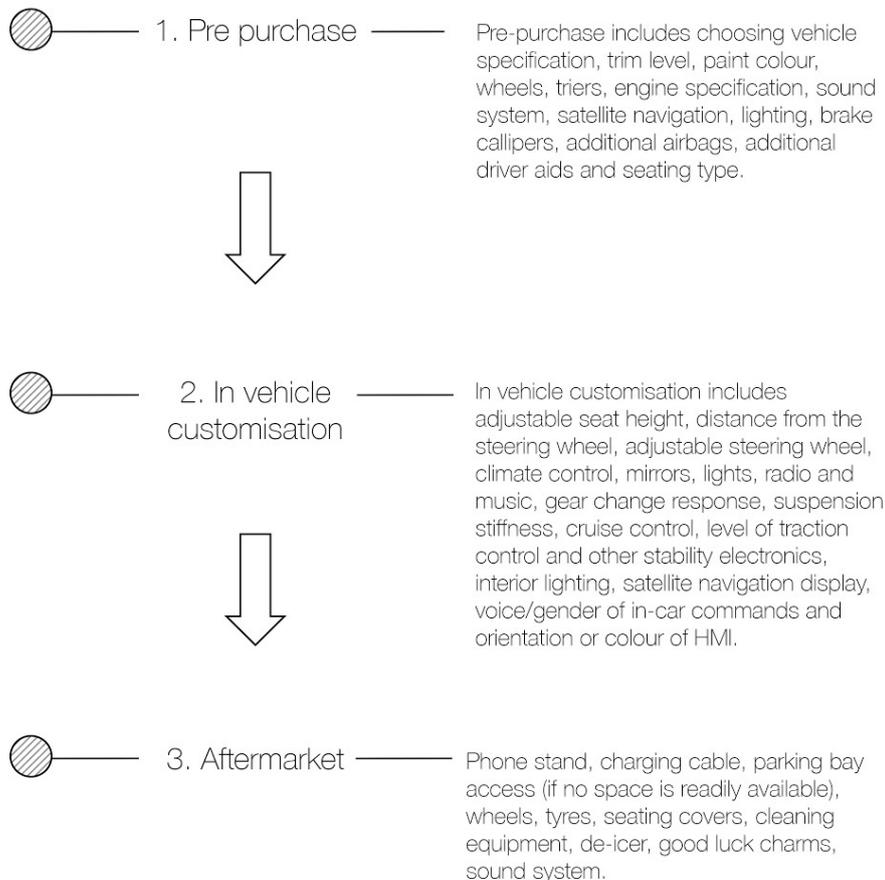


Figure 1 A designer tries to make sense of a current vehicle sales model in three steps

A contextual video (Figure 2) (Wu et al. 2019, March 19) was created to help designers construct a tangible scenario describing how car owners would use the proposed service. The video was designed to communicate “user expectations of situated use mainly concerned ease-of-use, trust building and previous experiences of related technology as well as stimulation” (Pettersson, 2017). The video shows users’ situations, amplifying key interactions needing to be designed, and provides a draft of potential design provisions while leaving the design of specific features to later development phases. This research step acts as a knowledge sharing platform with dual purpose: clarifying and communicating user experiences and expected solutions within the design team and creating a more tangible visualised design hypothesis for further user empathy and feedback sessions.

People are used to customising interior features such as seats, dashboards, and technology, and allowing such changes after the initial purchase opens opportunities for users to keep their cars longer and recycle components and materials they no longer need. With an engaging service model, customers could access and compare information about such options and be encouraged to make sustainable choices. The contextual video *Motoring Makeovers* incorporates findings from previous research phases to tell a story about Laura, a fifty-three-year-old whose youngest son has just left home. She no longer needs a car with six passenger seats and her business needs a car with a spacious boot. She goes to her car company’s Design Lab to see how she can upgrade her current car to fit her requirements, where she is given a tablet to make modifications until she is satisfied. The service features described in this video include making the boot bigger and reducing passenger space; changing the cars’ colour; changing car components such as the front lights, dashboard and drivers’ seat; and selecting and changing the fabric of the seats.



Figure 2 Contextual video for *Motoring Makeovers*. Left to right: An owner decides to upgrade her car after recent life changes; Customising her car at the brand’s Design Lab; Looking at vehicle material selection and information on a tablet

In order to explore the possible features of a *Motoring Makeovers* service in more detail, we created an interactive display on a tablet so car owners could experience our concepts and give feedback on specific designs. For example, when users hold the tablet over material samples and vehicle components, different levels of information about the item appear on the display (Figure 3). This way the design hypothesis becomes more concrete, demonstrating experiences that can be designed to become real vehicle products.

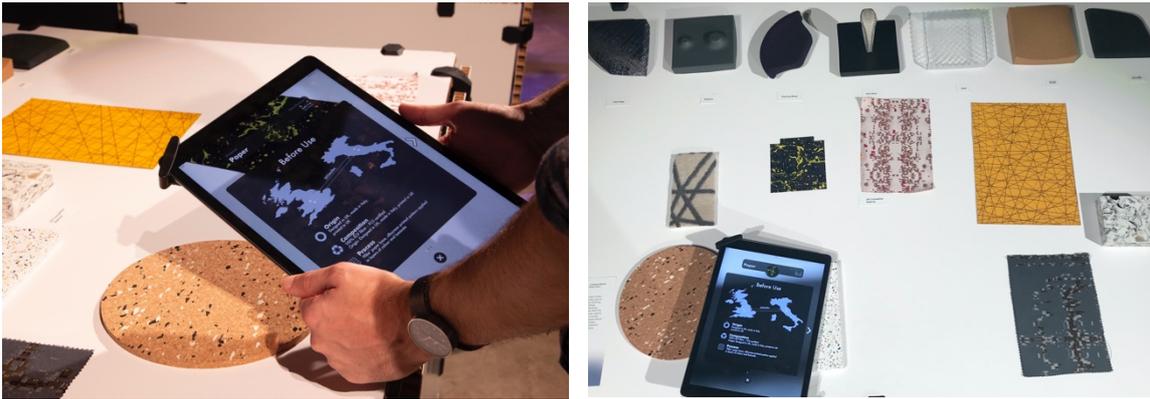


Figure 3 Left: *Motoring Makeovers* tablet interface; Right: Customisable car parts and materials

3. Iteration

The iteration phase aims to user test and refine the design hypothesis. As Stanford d. school's Test stage suggests, this is another opportunity, in addition to Empathise at the beginning of the process, to return to scrutinise users' experiences. We collected feedback from randomly selected car owners who experienced our vehicle service design features at a workshop with five participants who represented different genders and age ranges (27-67), to test the design hypothesis and gain more information about the experience. A vehicle showroom tour was arranged for the designers to immerse themselves in typical car owners' experiences when purchasing and maintaining vehicles. These research methods were selected so user experiences could be investigated repeatedly and with more focus on expectations and assumptions of future visions so the design hypothesis could be developed into more detailed features for vehicle services and interfaces.

The design proposition is getting clearer for the research team - the key features that the *Motoring Makeovers* service will allow and support so that car owners can adjust and adapt their vehicle to their needs over time. We have investigated the main reasons why people want to change their car however we need more experience data to support the service design. Experience of expectations such as how they will keep beloved car parts and how they would like to access the service if they accept the idea will be perfect design evidence. At the workshop, as well as asking for reasons for changing their car, which parts they would like to change and keep, and watching the contextual video, we introduce a session to discuss their expectations. We provided a barometer with a list of "few things changed" to "many things changed" for their "old car" and asked them to build their own package to upgrade their car by placing provided cards on the barometer (Figure 4).

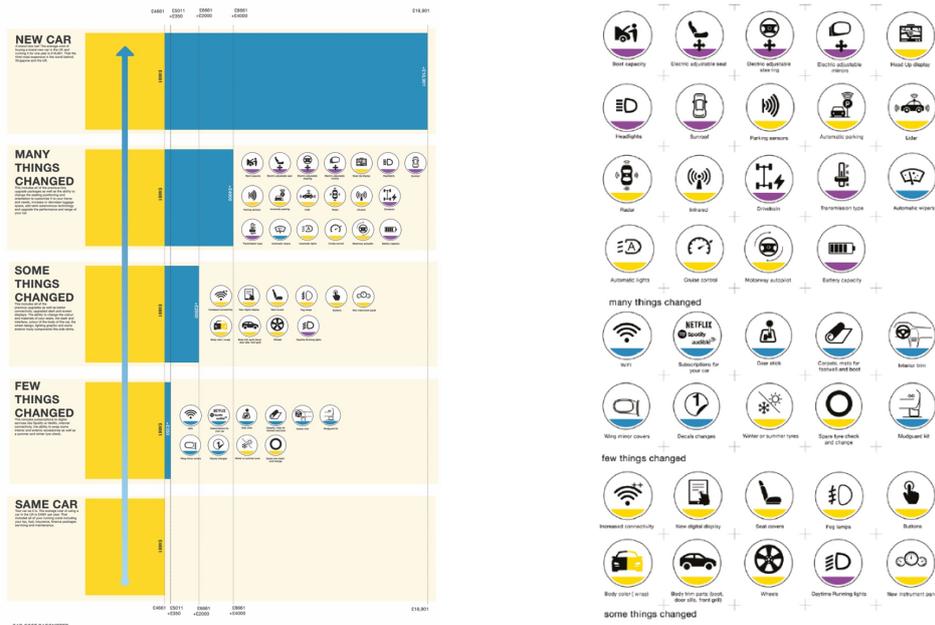


Figure 4 Left: Car upgrade cost barometer; Right: Vehicle component cards

When people discussed past and current experiences, we found they felt the same as we observed previously. For example, people want to dispose of an old car because of depreciation, the car reaching the end of its life, or new functionality being released. The parts of the car they wanted to keep varied: some mentioned functions, for example, cruise control; some mentioned components such as heated leather seats; some car size; one participant mentioned emission standards and government policy. When people discussed expectations for future services, their feelings were a mixture of being happy to try something new and being nostalgic about old functionality/components they enjoyed using. Table 5 summarises expectations and judgements when imagining a vehicle upgrade service.

Table 5 Experience expectations for future services

Potential design features	User expectations
Things to be changed	Functionality, safety and appearance
Number of upgrades	10 to 24
Popular upgrades	Electric seats and mirrors, automatic lighting, radar, parking sensors, Wi-Fi connectivity, carpets/ mats for footwells/boot
Acceptable price	~£4,000 (upgrade service)
Expected upgrade frequency	Dependent on items and existing features of car - some may be relevant after six months, others two years
Information to show with potential upgrades	Material durability; Ease of keeping clean; Environmentally friendly; Ethically sourced

To investigate vehicle customer experiences, the designers visited car showrooms (Figure 5) of Hyundai, Land Rover and Tesla in London, and focused on looking at their customisation offers related to aesthetics and purchasing. All the showrooms were set up similarly: each had car models on display, a wall of material samples and colours, and large touch screens which customers could interact with to investigate customisation options and personalised payment plans. We found the brands offered much more limited customisation than we were expecting and saw potential for incorporating Virtual Reality or Augmented Reality, as well as introducing sensory elements, to connect customers with car models and provide more customisation experiences. Implementing these types of service as part of the aftersales business would offer a very different experience for potential car buyers.

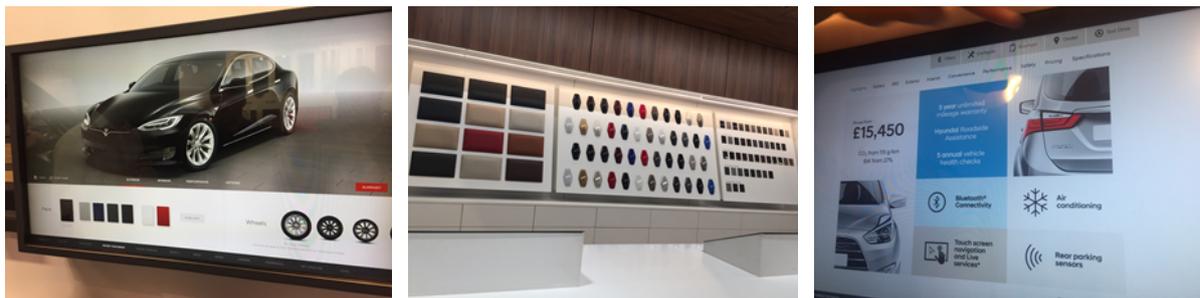


Figure 5 Vehicle showrooms: Left to right options - car accessories, car body colours and finance

4. Proposition

Proposition is the concluding phase where experience data is turned into final design deliverables. The goal is to polish the design proposal and produce a tangible design visualisation, leaving space for discussions and decision making by clients or sponsors. The deliverable should indicate the specifics of the service design and business models including details such as subscription frequency, pricing models and commercial touch points.

We created a video (Figure 6) (Wu et al, 2019, March 14) showing service touch points via tablet to communicate the designed features for service options and the component customisation process. As we moved from contextual to concept video, we crystallised the ideas as comprehensive user interfaces for each scenario. The video starts with an owner in the brand's Design Lab holding a tablet to modify their current car. Design features are represented with detailed interfaces giving a concrete vision of how to use the service. Service packages can be established by choosing and changing multiple components, prices of the changes are calculated, and the results of adding or changing different types of components and their materials can be seen in a visualisation of their own car.

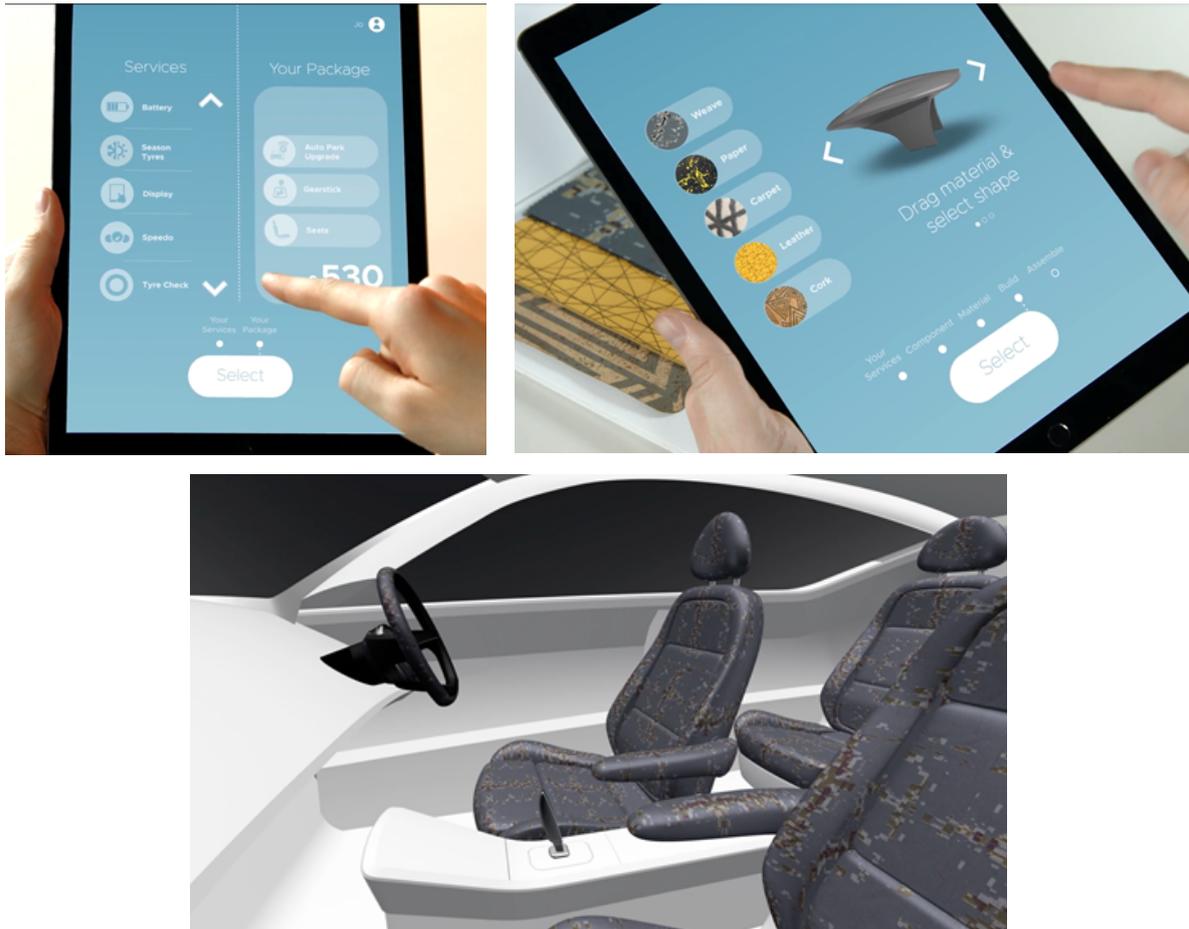


Figure 6 The final concept video showing how users can use the vehicle upgrade service. Clockwise from top left: choosing a service package and calculating the price; viewing and selecting types and materials of car components; viewing the upgrades in the user's own car

3. Discussion

By describing the process between analysing user experiences and creating design proposals using our vehicle ownership experience research as an example, we see the challenges - how to decide which scenarios include valuable experience data, how much experience data is enough for generating design proposals, and what types of proposal are appropriate.

Determining which scenarios to investigate is a critical step at the beginning of experience driven research. Defining useful scenarios is dependent on the projects problem statement, for example, *Motoring Makeovers* was intended to observe user habits and behaviours when owning cars so we could identify design opportunities for new vehicle services. We targeted looking at experiences of ownership for activities such as purchasing, maintaining and recycling cars. The decision on what to focus on is based on a complex judgement of whether potential design opportunities that the experiences point to can lead to mass or niche markets. We chose to focus on aftersales as it seems to be a neglected area.

How much experience data is enough and what types of data are effective for generating design proposals is the trickiest question. During research there should be several phases of experience data collection, each of which are followed by testing outputs generated by analysing the data. We started with telephone interviews and used the knowledge gained to design the empathy workshop. As we gained more understanding from workshops, we conducted more focused observations with journey shadowing. After creation of the design concept we conducted another empathy workshop to verify the idea and obtain more experiential insights for user interfaces and service designs. Experience data will only be valuable when looking for solutions relevant to the market with potential to be accepted by customers. The automotive client interview and showroom tours were vital for acquiring business insights necessary to validate the proposals.

Design proposal formats differ at each stage. The user experience collection and analysis phase design proposal can be a title and sentence. During ideation, design proposals can be sketches, visualising ideas quickly. A low-cost interactive prototype is suitable once the design direction is clearer. For the final research deliverable, a tangible demo/prototype accurately describing product features is appropriate.

Our four-step research process from user experience to design proposals presents a typical process of design driven concept proof research as applied in the automotive field. This research process is derived from a mix of academic study and business innovation and can be applied to a broad range of design fields such as product design, digital design and service design. The steps to unpack ownership into different topics and to evaluate potential concepts by summarising the value for end users and the client ensures that the designers look at design aspects that might be ignored by normal market research or when only focusing on designing forms. Breaking down ownership behaviours by identifying three steps – pre-purchase, the use of product and maintenance - helps designers immerse themselves in the context of the ownership lifecycle in order to find out what the current product can not provide. The car upgrade cost barometer was inspired by the Card Sorting method and can be useful for investigating what features end users expect to have and their priorities once a concept has been decided.

4. Conclusion

Most of the way we organised our research process successfully translated segmented user experiences into a design proposal. The combinations of selected research methods and design techniques were justified by each phase's objectives and the target for the ultimate research outcome. There are limitations for this type of research in terms of methods and final design proposals. Although the mixture of experience data analysis and design sketches, visualisations and briefs as written text helped the research as it moved smoothly from user experiences to design conclusions, a lack of specific knowledge of emerging vehicle technologies made our ideation development ungrounded.

Designing for advanced technological innovations is a challenge for experience designers. People's current experiences can only say what works now, not what will work in the future. Even as we gathered user experiences and expectations, their future product insights might not be accurate or appropriate for real world implementations. Translating user experiences into design proposals for current markets and technologies might be feasible, but translating current user experiences into future facing design proposals is still to be explored.

There are many formats that are appropriate for each phase's design proposal with no absolute right way of doing it. Video demonstrations are constrained by time and budgets. A good storyboard together with two-dimensional product prototypes can be sufficient, with three-dimensional modelling showing every facet of the product more appropriate for others. The key is to set up a design hypothesis and continuously test it as research progresses with design proposals.

The paper authors hope to inspire a discussion to explore user experience research around the user led process and the approaches combining it with design processes. We believe further research development to reinforce the linkage between user led experience study and designers' interpretation and proposal is needed.

Acknowledgements: This research was sponsored by Hyundai-Kia. The financial support enabled the Intelligent Mobility Design Centre of the Royal College of Art to conceive and explore new areas in transport experiences, vehicle design, digital technology integration, mobility systems and other research topics. We would like to thank Hyundai Motor's German and Korean offices for their involvement in feedback and review during the research.

5. References

- Biagioli, M., Grimaldi, S., & Ali, H. (2018). *Designer's Emotions in the Design Process*. Proceedings of the Design Research Society Conference 2018. <https://doi.org/10.21606/drs.2018.408>
- Bichard, J., Chatting, D., Clayton, W., Jain, J., Kirk, D., Ladkin, A., Marouda, M., & Yurman, P. (2015). *Family Rituals 2.0*. Helen Hamlyn Centre for Design, Royal College of Art.
- Buchenau, M., & Suri, J. F. (2000). *Experience prototyping*. Proceedings of the Conference on Designing Interactive Systems Processes, Practices, Methods, and Techniques - DIS '00, 424–433. <https://doi.org/10.1145/347642.347802>
- Design Council UK. (2005). *Eleven lessons: Managing design in eleven global brands*.
- Desmet, P., & Hekkert, P. (2007). *Framework of Product Experience*. International Journal of Design, 1(1), 13-23.
- Dewey, J. (1980). *Art as experience*. Penguin Group (USA) Inc.
- Dow, A., Vines, J., Comber, R., & Wilson, R. (2016). *ThoughtCloud: Exploring the Role of Feedback Technologies in Care Organisations*. Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems - CHI '16, 3625–3636. <https://doi.org/10.1145/2858036.2858105>
- Forlizzi, J., & Battarbee, K. (2004). *Understanding experience in interactive systems*. Proceedings of the 2004 Conference on Designing Interactive Systems Processes, Practices, Methods, and Techniques - DIS '04, 261. <https://doi.org/10.1145/1013115.1013152>

- Forlizzi, J., & Ford, S. (2000). *The Building Blocks of Experience: An Early Framework for Interaction Designers*. DIS '00: Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques, 419-423. <https://doi.org/10.1145/347642.347800>
- Garcia, S. E., & Hammond, L. M. (2016). *Capturing & Measuring Emotions in UX*. Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems - CHI EA '16, 777–785. <https://doi.org/10.1145/2851581.2851605>
- Gaver, B., Dunne, T., & Pacenti, E. (1999). *Design: Cultural probes*. *Interactions*, 6(1), 21–29. <https://doi.org/10.1145/291224.291235>
- Hassenzahl, M., & Tractinsky, N. (2006). *User experience - A research agenda*. *Behaviour & Information Technology*, 25(2), 91–97. <https://doi.org/10.1080/01449290500330331>
- Holtzblatt, K. (2016). *Contextual design: Design for life* (Second edition). Elsevier.
- Institute of Design at Stanford. (2010). *An introduction to design thinking*. Retrieved from https://static1.squarespace.com/static/57c6b79629687fde090a0fdd/t/58ac891ae4fcb50f1fb2f1ab/1487702304601/Facilitator%27s+Guide_Design+Thinking.pdf
- Karapanos, E., Zimmerman, J., Forlizzi, J., & Martens, J.-B. (2009). *User experience over time: An initial framework*. Proceedings of the 27th International Conference on Human Factors in Computing Systems - CHI 09, 729. <https://doi.org/10.1145/1518701.1518814>
- Koskinen, I., & Lee, J. (2009). *Inspiration, Interpretation, Explanation: Inference in Constructive Design Research*. IASDR 2009.
- Koskinen, I., Mattelmäki, T., & Battarbee, K. (2003). *Empathic Design: User experience in product design*. IT Press.
- Kouprie, M., & Visser, F. S. (2009). *A framework for empathy in design: Stepping into and out of the user's life*. *Journal of Engineering Design*, 20(5), 437–448. <https://doi.org/10.1080/09544820902875033>
- Norman, D. A. (2005). *Emotional design: Why we love (or hate) everyday things*. Basic Books.
- Orth, D., & Thurgood, C. (2018). *Designing Objects with Meaningful Associations*. *International Journal of Design*, 12(2), 14.
- Pettersson, I. (2017). *Traveling from fascination to new meanings: Understanding user expectations through a case study of autonomous cars*. *International Journal of Design*, 11(No. 2), 1–11.
- Rampino, L. (2011). *The Innovation Pyramid: A Categorization of the Innovation Phenomenon in the Product-design Field*. *International Journal of Design*, 5(1), 3-16.
- Suh, K.-S., & Chang, S. (2006). *User interfaces and consumer perceptions of online stories: The role of telepresence*. *Behaviour & Information Technology*, 25(2). <https://doi.org/10.1080/01449290500330398>
- Tullis, T., & Albert, B. (2013). *Measuring the user experience: Collecting, analyzing, and presenting usability metrics* (Second edition). Morgan Kaufmann.
- Vermeeren, A.P.O.S., Law, E.L., Roto, V., Obrist, M., Hoonhout, J., & Väänänen-Vainio-Mattila, K. (2010). *User Experience Evaluation Methods: Current State and Development Needs*. Proceedings of NordiCHI 2010. <https://doi.org/10.1145/1868914.1868973>
- Visser, F. S., Stappers, P. J., van der Lugt, R., & Sanders, E. B.-N. (2005). *Contextmapping: Experiences from practice*. *CoDesign*, 1(2), 119–149. <https://doi.org/10.1080/15710880500135987>
- Wilson, A., & Tewdwr-Jones, M. (2019). *Let's draw and talk about urban change: Deploying digital technology to encourage citizen participation in urban planning*. *Environment and Planning B: Urban Analytics and City Science*. <https://doi.org/10.1177/2399808319831290>

- Wu, J. (2012). 从文化模式中寻找数字工具的价值——以《将生活注入到文化遗产中》项目为例 [Exploring the Value of Digital Tools in the Cultural Pattern: A Case Study of Breathing Life into Cultural Heritage], *Chinese Journal of Art and Design*, 1(2012), 97-99.
- Wu, J., Nasir-Tamara, L., Johnson, S., Hesseldahl, K., Quinlan, D., & Riza, B. (2019, March 14). Motoring Makeovers concept video. <https://vimeo.com/323841861>
- Wu, J., Nasir-Tamara, L., Johnson, S., Hesseldahl, K., Quinlan, D., & Riza, B. (2019, March 19). Motoring Makeovers contextual video. <https://vimeo.com/325159560>
- Xu, W. (2012). *User Experience Design: Beyond User Interface Design and Usability*. *Ergonomics - A Systems Approach*. <https://doi.org/10.5772/35041>

About the Authors:

Jiayu Wu Dr. Wu leads and works on collaborative innovation research projects at the Intelligent Mobility Design Centre (IMDC) of the Royal College of Art (RCA), bringing together academics, industrial partners and students to design and deliver research and knowledge transfer projects for emerging mobility experiences. Her focus is digital integrated human experience and disruptive approaches for addressing existing and emerging mobility problems. Dr. Wu is an innovation methods educator for technology and business integration, and a professional user experience designer for the new mobility and automobile industries. She lectures on the impact of design innovation approaches in business development and social engagement and works with businesses of all sizes on concept design generation and production. Her research interests include exploring how user experiences influence cutting edge technology in new and emerging markets and vice versa.

Dale Harrow Professor Harrow is Chair of the IMDC and Head of the Intelligent Mobility Design Programme recognised as a global centre of excellence in automotive and design education. As a former Dean of the School of Design at the RCA he introduced new Programmes in Service Design and International Programmes in innovation design and championed multi-disciplinary design methods through new curriculum development. He is an international opinion former and commentator and media persona on design the automotive and transport industry. He is a multi-award-winning designer, academic leader and a researcher and is regularly cited as one of the most influential and important figures in the automotive industry. He is committed to design education and is always keen to raise the intellectual debate about vehicle and automotive design.

Katrine Hesseldahl Ms. Hesseldahl started her Ph.D. project with the Burberry Material Futures Research Group (BMFRG) at the RCA in 2019. The primary aim of her project is to establish a framework for designing consumer experiences that contribute to a circular economy by inviting and empowering consumers

to participate in closing material circles. Her work aims to intrigue, interest and invite people to take steps in the direction towards a more sustainable, fair, fun and beautiful future for our society. She is deeply concerned with the scale and complexity of the problems we are facing today, for example climate changes, overuse of resources, social inequality, and feels a natural responsibility to be part of creating solutions for these problems.

Samuel Johnson Mr. Johnson is a vehicle designer with a range of experience and skills who worked at the IMDC, specialising in digital concept generation. A graduate of the RCA's Vehicle Design course he has also worked in product, furniture, and transport design. Prior to joining the RCA he gained a degree in Transport and Product Design from Coventry University. He has a strong interest in translating research into tangible design outputs and a common theme throughout his work is exploration of the relationship between people and their wider environment.

Sheila Clark Dr. Clark is a design researcher who completed her Ph.D. in Vehicle Design at the RCA in 2019. She has been working at the IMDC's Hyundai-Kia Innovation Laboratory assisting with the design and facilitation of user experience workshops, project briefs, literature reviews and writing reports on the projects Emotional Tech and MORPH. She has developed future material concepts for Samsung and Studio Edelkoort, collaborated on practical research projects with Ford, Lotus and Nissan, and exhibited prototypes in London, Japan and the United States of America. While developing sustainable materials for automotive interiors she has worked with global industrial manufacturers and supply chains throughout the motor industry.

Daniel Quinlan Mr. Quinlan is a Research Associate at the IMDC. His work as a vehicle designer ranges from developing future facing production models to creating abstract concepts. He has worked on the government-funded GATEway project, the Future London Taxi project and managed projects in the Hyundai-Kia Innovation Laboratory. He graduated from the RCA's Vehicle Design programme in 2014, working as a Project Researcher in the Age & Ability Research Lab at the Helen Hamlyn Centre for Design. He was part of the team that set up the IMDC, with his focus on designing and researching a 'new' age of transport and responding to challenges and opportunities that new technologies open for the development of design related to physical movement in the information age.