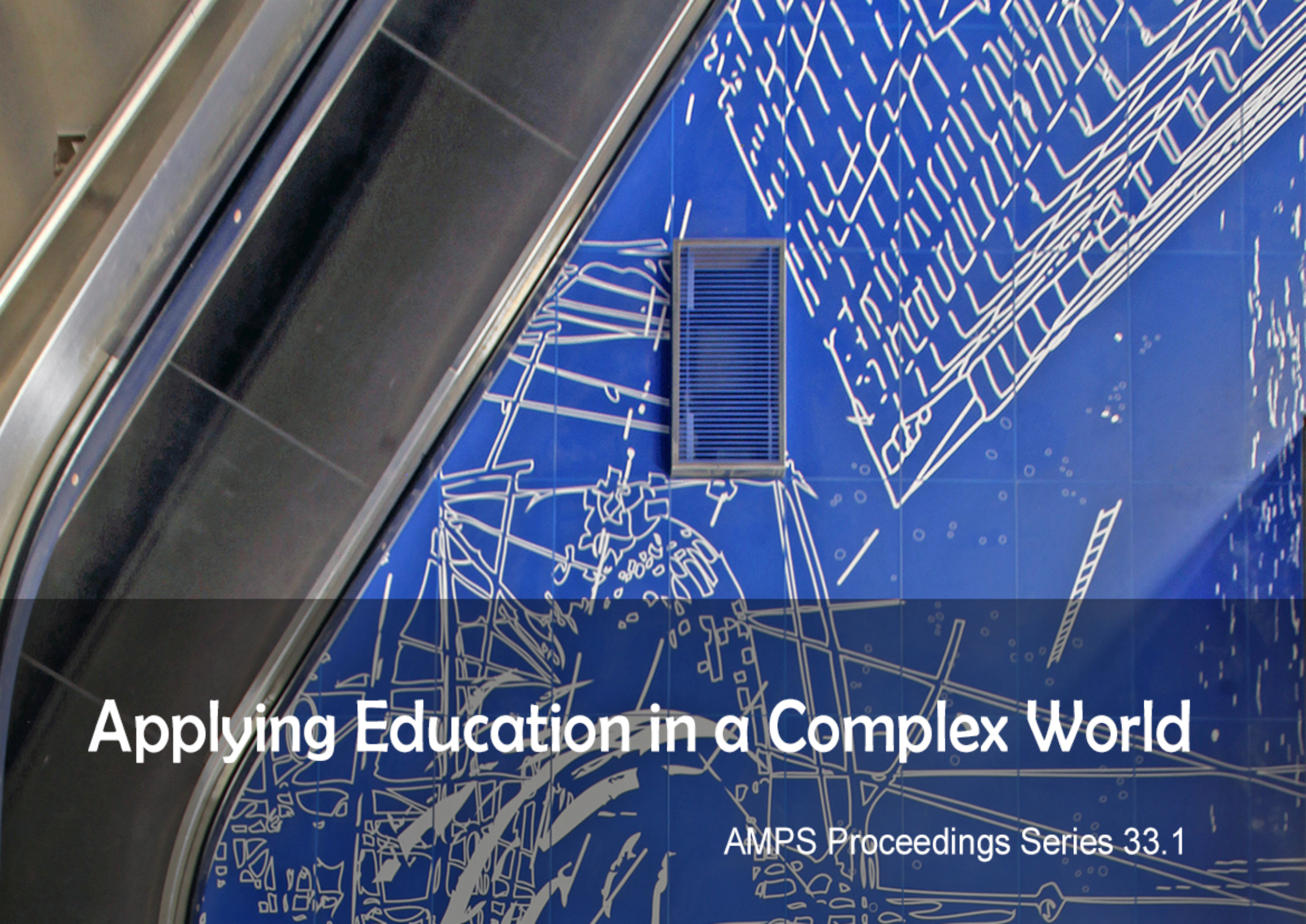

Applying Education in a Complex World

AMPS Proceedings Series 33.1

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Applying Education in a Complex World:
Teaching and Learning

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INTRODUCTION

Applying Education in a Complex World:
Teaching and Learning

Complexity theory, complex systems, complex strategies and a complex world. The range of concepts, practices, scenarios and metaphors through which we consider intricate, interconnected and changing phenomena is vast. The impact of this world view on how we operate is equally large. The education sector, like all those that make up the tapestry of contemporary societies and economies is not – and cannot be – immune.

The argument that the world in which today's students will eventually work, will be different and more complicated that the one they currently know, has become a truism. It guides our thinking in multiple ways. In this scenario, education is becoming equally fluid. We not only prepare students to face the changes we see occurring today, but shifts and developments no one expects, or predicts. We are obliged to think outside disciplinary boundaries. We adapt constantly to changing methods of teaching. We address new and emerging professions. We negotiate the demands of learners, parents, industries and business.

While this scenario may be contested by some, it is also welcomed by others. These proceedings, and the conference from which they come, reflect on its implications from various disciplinary standpoints.

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INTEGRATED MULTI-DISCIPLINARY APPROACHES IN HIGHER EDUCATION TO CONCEIVE FUTURE MOBILITY AND TRANSPORT DESIGN PRACTICE IN EXTREME SCENARIOS

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INTRODUCTION

The complexity of contemporary society and mobility imposes the rethinking or adaptation of well-established ways of designing products, services and infrastructures which are no longer effective in supporting or tackling systemic and sustainability provisions or problems. Concurrently, developing experiential learning in this regard is required to adopt novel teaching methods and strategies in higher education, enabling students' effective collaboration and co-creation whilst supporting their design thinking and skills formation.

This paper sets out to critically reflect on collaborative, research-based, and industry-informed integrated approaches to higher education through two distinct, but complementary project case studies, developed respectively at Northumbria University and the Politecnico di Milano. An analysis is provided to illustrate how students approach projects through design (thinking) and innovation methods alongside their developmental skills, which are used to deal with complexity, and propose well thought-out solutions.

The two case studies explore future mobility scenarios where autonomous vehicles (AVs) are enabled by artificial intelligence (AI) to either respond to extreme situations (the first case study) or ensure inclusion and accessibility for impaired users (the second case study).

Key design and educational considerations are derived from an evaluation of how technologies and development methodologies may enable graduates to proactively face the challenges of the fast-evolving transportation design sector.

THE ROLE OF ENVIRONMENT AND TECHNOLOGY IN SHAPING MOBILITY AND EDUCATION

In the field of mobility, the transition towards a 'Net Zero' emissions (NZE) landscape by 2050 is driving crucial decisions in all areas of transportation.[1] For this reason, producing education capable of tangibly considering and applying some of the 17 United Nations (UN) Sustainable Development Goals (SDGs) is becoming increasingly crucial.[2] The two featured case studies align with the objectives of the SDGs which focus on inclusivity, sustainability, industrial innovation, urban infrastructures, and communities (numbers 3, 4, 9, 11, 12, 13 and 17).

Figure 1. United Nations Sustainable Development Goals (adapted from United Nations). Highlighted are the goals considered within the two case studies.

Current transportation design practice does not only focus on the aesthetic elements or appearance of vehicles, but also on the user and the ergonomics-related aspects, which have a direct (or indirect) impact on the usability of mobility products and services. This type of education, often referred to as vocational, is extremely focused on teaching and practicing a very specific skills set – creativity, drawing ability, feel for form, physical and digital model making, graphic presentation techniques – to enable students to develop those capabilities and be competitive in the employment and careers marketplace.[3] Nonetheless, conceptual and critical thinking skills must still underpin those other skills and processes.

What clearly emerges is the need, in both the industry and design education, to train university students not only to develop (for instance) vehicle exteriors and interiors, but also to be acquainted with technical developments such as Artificial Intelligence (AI) and disciplines such as service design and interaction design.[4] Higher education and academic training should prepare students for the complexity of the multifaceted transportation design field, in which industrial practices, Information and Communication Technologies (ICTs), sustainability, and service-related factors become intertwined, generating fast-evolving and socially influencing systems.[5]

The complexity of the mobility and transportation field in this age of technological advancement and social change [6] requires a more focussed user-centred design approach to avoid inequalities and exclusion.[7] It also necessitates a more holistic set of project methods which do not strictly revolve around the actual design of (for instance) the respective vehicle right from the outset of the project. In this regard, the ability to work in multi-disciplinary teams is key to undertake all relevant research about trends, user behaviours, travellers' needs, and to subsequently make sense of those findings and insights through the application of design thinking methods.

CASE STUDY 1: FURTHERING MOBILITY FOR TOMORROW'S SOCIETY

The MA/MSc Multi-Disciplinary Innovation (MDI) is a unique programme which enables students from diverse (disciplinary and place of origin) backgrounds to work together on 'live projects', in a simulated agency environment, to address societal, technological, organisational or commercial issues through the application of design-led innovation methods and practice.

Multi-Disciplinary AV + AI Mobility Research Project

The selected design-led innovation project was a 12-week exploration activity that involving six Northumbria University's Multi-Disciplinary Innovation postgraduate taught students (Amarjit Deo, Avanti Sukma, Charlie Richardson, Charlotte Knott, Joe Iacomo, Josh Robson, and Yan Shum) working in a team, alongside academics and industry collaborators (Innovation SuperNetwork, Innovate UK, Creative Fuse North-East, Orange Bus, Urban Foresight, Great Exhibition of the North). The aim was to further mobility for tomorrow's society by exploring future mobility scenarios in which artificial intelligence (AI) could play a crucial role, within a fully autonomous vehicles (AVs) environment, to enhance people's lives.

The MDI cross-disciplinary team was initially tasked to explore smart cities and AI as an initial research task to gain deeper understanding of ICT-enabled city environments (as well as some more rural commuting hinterlands) and a range of self-driving passenger's experiences. This design-thinking informed investigation helped develop insights in both future society trends, personas profiling and e-mobility developments alongside what AI means on a personal user's level, by considering the benefits and risks involved in a social and mobility context. [8]

To understand the role of AI and AV within tomorrow's society in connection with mobility, emerging mega trends such as AI applications, data economy, demographic shift, rapid urbanisation, and mobility futures were also investigated and analysed. [9]

This design-led research approach enabled the student team to define the project aims further, in a clear and focused manner.[10] These were to:

–Explore society's emerging and evolving relationship with mobility.

–Build understanding through personas, workshops, and scenario mapping.

–Propose a new set of user journey scenarios for 2030 and beyond, augmented by AVs and AI to enhance individuals' lifestyles.

Despite the complexity of data and insights gathering, the fundamental user-focussed guiding principles were kept in mind around the use of space, time, and wellbeing. This initial research was instrumental in the mapping and definition of both pain points and areas of opportunity, to design a set of future journeys and user experiences leading to a series of value propositions and recommendations for stakeholders by placing human factors at the centre stage.

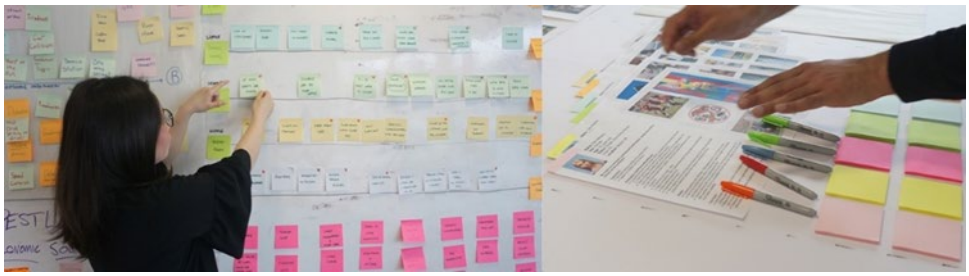

Figure 2. Mapping of research findings and insights.

Considering the extended project timeline, the adopted methodology enabled the team to construct and define a *problem/opportunity space* which then led to the creation of well-thought-out *solution space* outcomes.[11]

The project was structured in a way that enabled the team to hold several key reviews to share, discuss project progress but also to test concepts and scenarios through co-creative workshops involving academics, industry, and stakeholders in the explorative process.

Scenario	Rationale
Pregnant woman in an AV	How should an AV react when placed in a situation where an emergency requires you to drive radically? What affordances need to be in place? How do you inform other road users around you?
Bus crash during rush hour	In a bus crash, how would an AV handle this? Could it connect with the city to talk to other vehicles, or route medics to the situation?
Peloton on a country road	How does an AV navigate a road with a group of cyclists, how does it signal intent and ensure other road users are safe?
Border control	What can an AV do to aid, enable frictionless borders? What data can be handed over and where else could this data be actioned? (ie: car parking, tolls, congestion zones)

Figure 3. Extreme Scenarios Board tested in situational simulations.

This method of enquiry and concurrent scenario development placed the team and other research participants in a more challenging position, to ask first and then seek answers to a set of difficult and uncomfortable questions which related prominently to privacy, passenger safety, legislation, and morality. Co-creative workshops proved to be effective in developing those severe scenarios which were conceived to test users' behaviour, in relation to the AV response in connection with AI and within the surrounding mobility infrastructures and services. To better appreciate this speculative work, some key questions associated to each scenario are captured in the table below.

The mere act of simulating those scenarios in a scaled-down version of a printed city and road environment, using people and vehicles as chess pieces, added an element of gamification to the scenario building exercise. Consequently, the created workshop environment was instrumental in the live discussion of each situation whilst making this activity lively, dynamic and focussed. Some of the main generated ideas which could be also applicable to other scenarios, provide some interesting guidelines to the future application of AVs.

Ideas	Insights
Emergency stop button / Dead man's Handle	A user must be able to stop an AV, either through an emergency stop button or dead man's handle.
Collision mesh	To reinforce safety, a detection zone is needed by default and is able to be commandeered by emergency services to get through traffic.
"Ambulance mode" conversion	A user must be able to convert their AV into an ambulance mode when appropriate and legal to do so.
Retrofit for legacy vehicles	AVs lack anthropomorphised features, and it's hard for legacy vehicles and other road users to read an AV's road intent; a retrofit would help understand intent, and help reduce anxiety.

Figure 4. Ideas generated from reviews and workshops.

The rationale behind those recommendations was based on the conducted workshops talking points in which the following questions were argued first and then identified as being critical to answer.

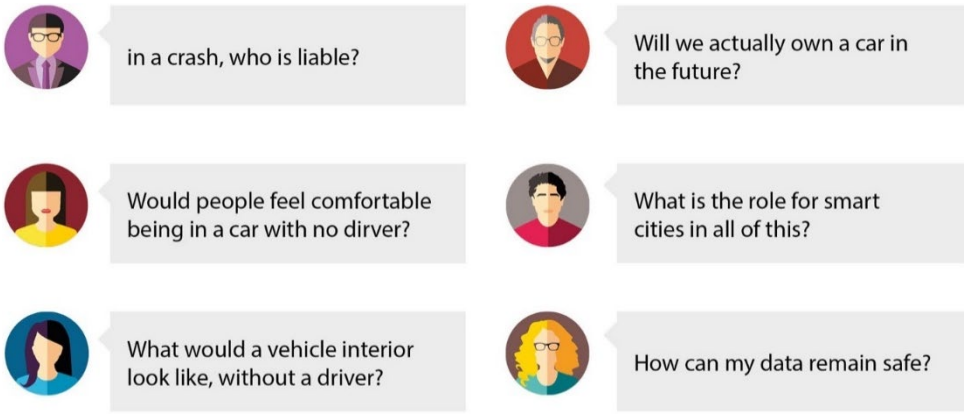

Figure 5. Summary of gathered key insights from workshops converging into concerns of trust.

Value Spaces

This project stage highlighting areas of opportunities within mobility through the adoption of AVs was tackled with the aim of considering positive approaches towards improving users' daily lives. Generating value spaces was instrumental in the way it allowed the team to produce outputs within a defined framework but also provided the necessary flexibility to develop and evaluate ideas without too many constraints apart from those embedded into the brief and research summary.

As the applied scenarios were used to test ideas and concepts, the process used to validate workshop outputs and generate value spaces, once again, enabled the team to concentrate on an investigation where objectivity and intellectual rigour represented fundamental principles of the entire process.

The team identified value propositions situated within two value spaces, namely commuting and emergency services, as spaces where AV and AI can play a role in enabling mobility to improve users' lifestyle.

Project recommendations

The value propositions produced by this project to position future user journeys in an AV environment, aided by the onboard AI, in predefined extreme scenarios were shared and discussed through workshops and presentations. The outcome of those research activities led to the definition of how passengers would experience and behave in inconvenient situations, with the support provided by the AV+AI.

Strategy development, as a final project stage, took place by mapping ideas across a strategic roadmap, which included a delivery timeframe and relevant project stakeholders. This plan was then broken down into a series of specific policy recommendations for governments and city municipalities, alongside another set of recommendations for vehicle manufactures, as concisely and graphically illustrated in the next few pages.

Figure 6. Set of recommended design principles for AV journeys.

Designing new AI-enabled products requires revised or innovative design methods that are transparent in their intent, and opaque to their inner workings, to ensure they are reliable, trustworthy, socially responsible, and ethically sound. Consequently, a range of user-centred design principles have been identified and proposed as an initial guide for any organisation seeking to design a future autonomous journey.

CASE STUDY 2: FURTHERING INCLUSION THROUGH URBAN MOBILITY SOLUTIONS

The Master programme TAD of the Politecnico di Milano has been running since 2008 as a specialising postgraduate taught course managed by the POLI.design [12] consortium. The course aims to provide graduates in Industrial Design, Architecture, and Engineering with a scientifically rigorous

training programme, allowing them to become competent transportation and car designers. This is achieved through:
-Industry-informed practice in collaboration with automotive design partner companies.
-Studio-based activities, which involve fundamental and advanced field-specific design practices carried out both individually and within teams. Such contents focus on the ideation, visualisation, and digital/physical prototyping stages of the design process to mirror most of the typical activities of an OEM Design Center.
-Research and practice-informed studio activities, which are delivered and facilitated by academics and experts from the automotive industry.

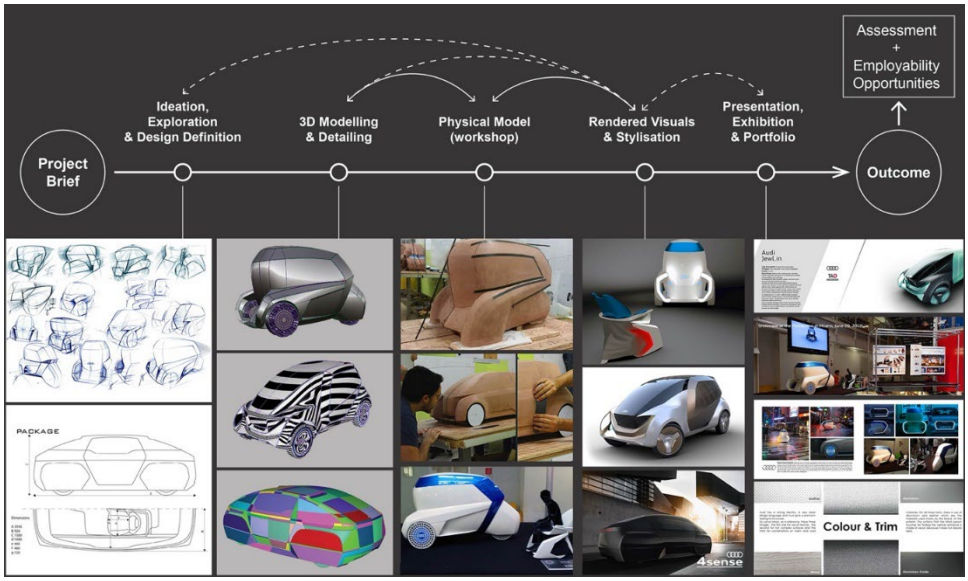

Figure 7. Key activities taking place within the TAD Masters course.

The integrated process applied within this course intends to mimic the field-specific industrial practice, and to train students on the most typical activities that happen within transportation and car manufacturers design centres. For this reason, teaching spatial awareness about complex forms is a key aspect of the course, and students are supported by the multi-disciplinary staff team throughout the process.
In line with the well-established transportation design practice, where multi-disciplinary teams collaborate towards the creation of complex projects, students are required to work in teams and to consider all the required stages that inform the conception, detailing, and communication of their project.

Three projects meeting specific customers' needs

The selected projects have been created in different editions of the TAD Masters; nonetheless, they share a common framework, which is characterised:
-by the collaboration with the same car manufacturing brand – that is Audi.
-by the type of technology – that is electric powertrain and fully autonomous drive.
-by the main goal – that is to address specific needs of people with impairments that reduce their ability to use current vehicles.

4 Senses

The first project is the vehicle which has been developed in 2015-2016 by a three-student team (Fabrizio Buonomo, Giuseppe Romano, Pasquale Smimmo). The name stems from the project aim to address the needs of passengers affected by visual impairments. The goal was to use the opportunities that will be available with fully autonomous vehicles to imagine a car of the not-so-distant future that can provide blind and visually impaired users with mobility opportunities through a specially designed vehicle.

Through several iterations, discussions within the team, and tutor-led design refinements, the concept was developed both in terms of vehicle architecture, interior configuration, and exterior design language with consideration of the end user.

As a result, the exterior features a Braille-based texture, running all around the car, designed to guide the passengers approaching the vehicle and to facilitate their access by guiding them towards the doors.

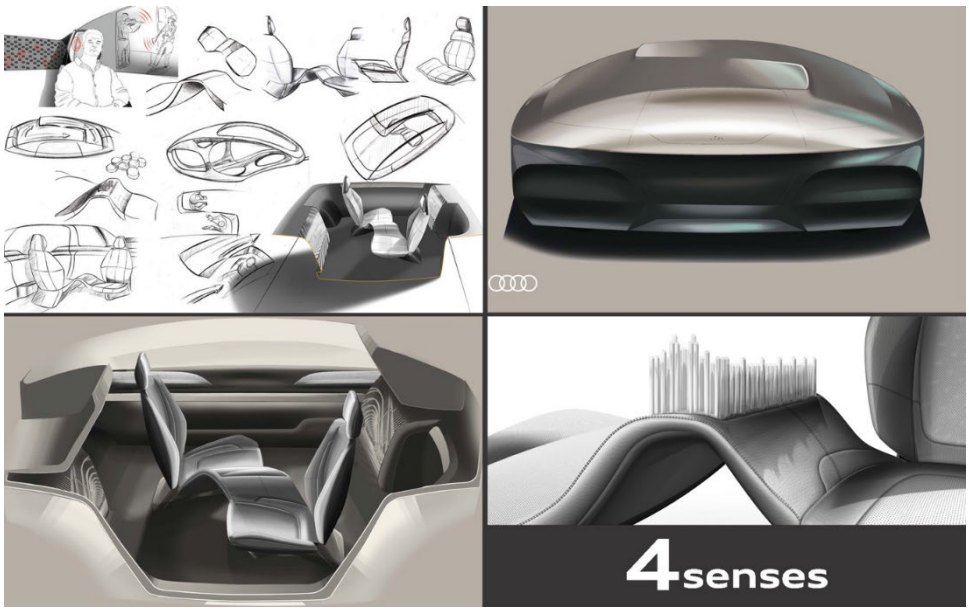

Figure 8. 4 Senses Initial sketches, exterior, interior layout, and tunnel haptic detail.

Given the freedom of interior design resulting from the fact that it is a full AV, the central idea was to design with the importance of touch in mind to enable blind people to feel, understand and perceive their surroundings. Based on this guiding theme, the interior of the vehicle was designed around two opposing seats with a central interactive tunnel, as this seating configuration allows passengers to have more direct frontal physical contact and better voice communication while providing easy access space for a service dog and luggage. The central tunnel reimagined the user interface as a haptic system that could also provide additional key information about the surroundings.

Audi_IN

This project was developed in 2017-18 by a four-student team (Daniel C. Busima Wamono, Edoardo Capi, Turgut A. Tutumlu, Ruhollah Kashfi Seyed). The name stems from the idea of comfortably entering the vehicle with a dedicated and purpose-built wheelchair. The goal of this project was to enhance the vehicle's flexibility, and to meet the needs of passengers with mobility impairments who need to use a wheelchair.

The result of the project is a dual vehicle concept: a self-driving car that can accommodate a wheelchair in a completely rethought way in which the user will no longer need to move from the wheelchair to the car and back. At the same time, the wheelchair can serve also as a last-mile mobility vehicle. The functional key element of the design is the front access point, which allows the user to comfortably both enter and exit the vehicle.

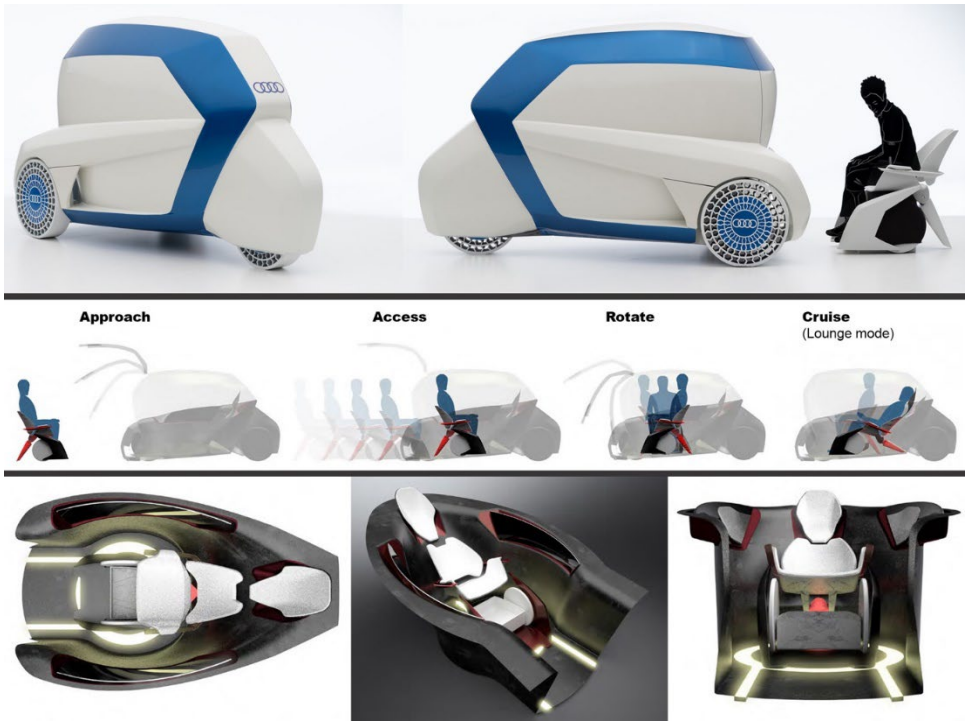

Figure 9. Vehicle's exterior and interior design, with integration of personal mobility device.

A secondary objective of this project was to address the negative preconceptions linked to a personal mobility device. It follows that the custom-designed wheelchair had been shaped as a customised personal mobility device but also as a sleek and smart product, able to address the current social stigma connected with such type of devices.

Jewl.in

This project was developed in 2017-18 by a three-student team (Gianluca Raciti, Giancarlo Temin, Esteban Wittinghan Quiñones). The name stems from the values of the project which intended to provide customers with a design which offers a support for mobility to elders giving them some status symbol-related design features at the same time. The proposed vehicle was designed for mature and elderly users – possibly travelling with children – and considered physical limitations that may impact their movements.

A special focus was dedicated to the design of side doors and main seats to reach a comfortable solution able to be easy to access and being perceived as a luxury item. The key choice was to redesign a 2+2 seating configuration in which the two main seats are located at the rear side of the vehicle, while the two front seats are dedicated to younger and more agile passengers.

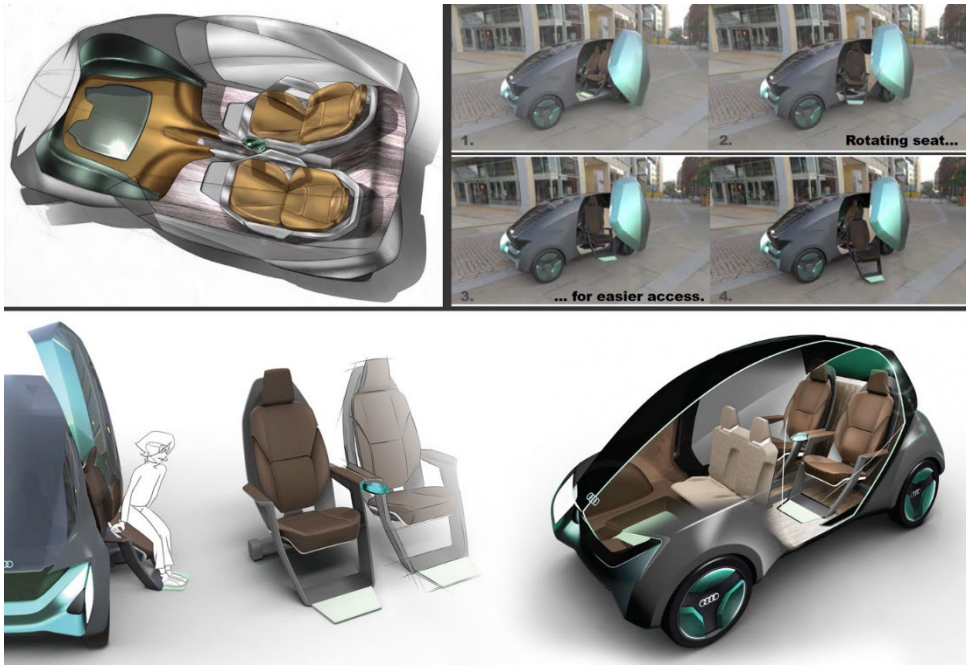

Figure 10. Design solutions facilitating the access to the vehicle.

CONCLUSION

The case studies presented above offer two distinct and different pedagogic, research and design approaches to mobility. As the first case study (from Northumbria University) was developed by team members from various backgrounds and not just design, more emphasis was placed on research and design-led innovation practice to produce coherent design proposals which do not rely particularly on vehicle aesthetics or other traditional transportation design skills. In the second case study (from the Politecnico di Milano) the situation is partly reversed as the proposed design work was executed to an elevated level of professionalism in terms of vehicle design development and presentation skills but, was also the outcome of an investigation where user needs were considered throughout the whole process.

The two different postgraduate taught courses and embedded approaches offer a wealth of interesting, valid considerations and lessons to be learnt in the area of future mobility and transport design education. First, to create ground-breaking solutions, the traditional subjective vehicle designer's mindset should be challenged through multi-disciplinary approaches to research. This would contribute to a more holistic analysis of specific issues or opportunities as well as the creation of credible design scenarios, which would better inform the ideation process, and lead to a deeper understanding of current and future mobility needs.

Junior designers in the field of transportation design should be trained to become mobility strategists, especially if they show a particular interest and ability in this subject matter. In addition, the integration of real-world professional practice within the learning experience is crucial to address the key teaching areas of brand values, concept ideation, user needs, CAD/physical modelling and visual presentation.

Passion and purpose should go hand in hand towards innovation practice, as long as design thinking and objective approaches are duly applied. A preliminary investigation about contemporary and future societal, user and industrial needs is necessary to achieve genuinely good and purposeful design. Especially for postgraduate taught courses, action research is needed to inform the core values of each

project and to answer some topical questions prior to the aesthetic approach to design. This will allow students to achieve inclusivity and empathy towards users and relevant stakeholders.

Effective mobility solutions should be informed by real-world challenges relevant to the UN SDGs, which identify a variety of challenging global and national local issues. Disruptive proposals should embed ground-breaking technologies, such as AI applied to AVs, alongside sustainability-related design principles such as Net Zero, and a deep understanding of target users.

It is worth pointing out that mono-disciplinary approaches can be quite limiting. To embrace and propose meaningful change in an increasingly complex world, including mobility, an interdisciplinary approach towards investigation and development is necessary alongside a solid design skill set. In this respect, higher education has a key role to provide students with a solid and practice-informed skill set, alongside real-world experience that will be essential in their future as specialised and yet also laterally thinking professionals.

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