BUROHAPPOLD
ENGINEERING

GLOBAL DESIGN SPRINTS:

HOW TO REIMAGINE OUR STREETS IN AN ERA OF AUTONOMOUS VEHICLES

OUTCOMES FROM CITIES AROUND THE WORLD

CONTENTS

- 2017 -

GLOBAL DESIGN SPRINT OUTCOMES

1. INTRODUCTION

Technological advancement for autonomous vehicles accelerated in 2015 and, suddenly, everyone was talking about a future of autonomous and connected vehicles. At BuroHappold, we wanted to understand what it might mean for our cities. How will our cities be impacted? Will there be more or less traffic? Which ownership model for autonomous and connected vehicles will prevail? These are questions that many have asked, but no one can really answer today – even with the most sophisticated forecasting models. We cannot predict how people will respond to such a disruptive technology and how they will behave; and we have no precedents that we can study.

After researching the key debates around the topic (see our research here), we decided against writing another report but, instead, decided upon hosting a series of Global Design Sprints. A Design Sprint is a structured form of testing design problems and identifying potential solutions. It originates in the design thinking developed at IDEO and the d.school at Stanford, and it is an approach that has been adapted by Google and other technology companies to develop new products. At BuroHappold, we adapted the format to attempt to solve problems in the urban environment by bringing together a diverse group of people with various expertise (see our Design Sprint Brief).

Using this format, we hosted a series of global events to speculate and brainstorm the question of :

'HOW CAN URBAN STREETS BE RECLAIMED AND REIMAGINED THROUGH THE INTRODUCTION OF CONNECTED AND AUTONOMOUS VEHICLES?'

By bringing together people from the technology sector, the urban design, planning, and engineering profession, academia and research, and government, we wanted to start a dialogue between experts who not necessarily meet in their daily work, but who have a lot to learn from each other. We also wanted to explore the issues raised by this question within the specific contexts of the cities within which we live and work. For instance, the introduction of autonomous and connected vehicles is likely to have different consequences in Riyadh where women are traditionally not allowed to drive than in Pittsburgh where ride sharing systems offered by Lyft or Uber are already celebrated as an alternative to a poorly built-out public transport network.

The following report is the result of this series of Global Design Sprints – a collaboration of over 280 sprinters from across the world. The executive summary compares the different discussions and outcomes of the Sprints and summarizes some of the key takeaways we collected. The ideas that emerged range from transforming a residential neighbourhood from a car-zone to a care-zone to the introduction of the flexible use of a road bridge based on the demand from commuters, tourists, cyclists, and vehicular traffic. We will let you judge how realistic and successful these ideas might be in a future of autonomous and connected vehicles. Most importantly, however, we hope to generate a debate around the topic. We believe that the Global Design Sprints are proving to be a great success and hope to see you at one soon!

PARTICIPANTS

- Pittsburgh : 33
- New York : 40
- Bath : 17
- London : 31
- Berlin : 33
- Riyadh : 56
- Dubai : 19
- Kuala Lumpur : 24
- Hong Kong : 30

1.1 EXECUTIVE SUMMARY

One of the posited drivers for investing in autonomous and connected vehicles is to make our streets safer and save lives. Over 90% of car accidents happen due to human errors. Computers will be able to avoid many of these accidents, therefore reducing vehicular death. This will however have unexpected consequences: In the US, for example, 20% of organ donations originate from victims of fatal traffic accidents. It is just one example of the many consequences we still need to figure out – many of them we might not even foresee yet. There is a real need for planners, designers, and policy makers to think about and anticipate the potential impacts of CAVs within the cities in which we live and work. Our Design Sprints have been created with the intention to provide a space to think interdisciplinary, collaboratively and innovatively about some of the fundamental policy, social, design, and technology issues that still lay ahead of us and need to be solved to enable society to reap the potential benefits that CAVs can bring. While most of us probably leave the Design Sprint with more questions than answers, the discussions help us to think about the numerous challenges, such as: the interaction between traditional cars and CAVs in an interim period; the ethical questions around decision-making and liability; the ownership models to promote successful outcomes; or the impact on public transport.

The ideas that emerge from the Design Sprints tend to reflect the different cultural contexts and current policy discussions in each of the cities in which they are held. While sprinters in Pittsburgh embraced the technology as an opportunity to improve on their relatively under-developed public transportation system, Berlin sprinters generally agreed that the public transport system has to be given first priority. Londoners seem to be keen on the adaptability of space. Most of the ideas coming out of London's sprint were about dynamic use of space – and dynamic pricing, maybe a reflection of London's existing road pricing scheme. Riyadh, by contrast, was pre-occupied with the separation of uses. While most ideas in the other cities had some sort of shared space, Riyadh's favoured ideas focused on separating vehicles from pedestrians to ensure that these different uses do not interfere. Interestingly, the ideas being promoted in Riyadh also mentioned the importance of emergency vehicles needing to be able to take priority – maybe reflecting the current congested state of major roads in Riyadh. It is one of the key takeaways from the diversity of the ideas from each city that any approach to deal with the spatial impacts of autonomous vehicles, be it a design or regulatory intervention, will need to take into account the specific urban context. This could include respecting the specific cultural behaviour of residents, responding to the physical urban fabric, taking account of the existing public transport network, or working within the regulatory context of a city. A dense city with a highly developed public transport system is likely to approach the emergence of autonomous vehicles differently than a sprawling city little served by means of a public transport network.

The outputs also suggest that looking into the future is going to be extremely challenging. As one of the sprinters at the London Design Sprint said, 'our minds are still thinking too much in the now'. This might be because it is hard to predict human behaviour. A look into the past, and the impact that subservience to the motor vehicle has meant for many of our current cites, shows us that we cannot blindly embrace the new technology; we need to (re)build our cities with foresight and a plan to capture and capitalise on what the future technology will offer. Moreover, we need to set the priorities now and ensure that the technology is shaped to those priorities and not vice versa. The opportunities are wide ranging, from the improvement of our streetscape, to the environmental protection, or the health and wellbeing of people. We need to be prepared to develop the necessary policies, plans and designs to manage the inevitable change. If we are reactive or careless, our cities will once more follow the lead of the cars (even if they are smart), adapting to their needs and priorities rather than to those of the citizen.

We see these Sprints as only the start of a debate that needs to continue over the next months and year. We plan to ensure that the debate is carried to other cities across the world and update this document accordingly. If you would like to organise and participate in a Design Sprint on this (or even another topic), feel free to contact us at BuroHappold (globaldesignsprints@burohappold.com).







BATH : OCTOBER 6 2016

2. BATH SPRINT

Our very first Design Sprint was held at BuroHappold's headquarters in the beautiful, historic city of Bath Spa in the South West of England. Bath is a uniquely compact city with a population of below 100,000. It is therefore a great test ground, not only for the introduction of autonomous and connected vehicles, but also for our Design Sprints. The historic city centre presents a set of opportunities and challenges: It is a popular tourist destination, attracting over 3.8 million day-visitors a year. The urban core is highly walkable, but also acts as a transport node for people from nearby towns. Furthermore, Bath is located on the rail line between London and Bristol and therefore hosts many who live in Bath or one of the nearby towns, but commute to London or Bristol. Hence, the mixture of pedestrians and vehicles can create high levels of congestions in the urban centre.

Jon Foley, BuroHappold's Technical Director of Transport & Mobility gave a short introduction to the initiative as well as the topic of autonomous and connected vehicles, summarizing the research that BuroHappold has undertaken. Anna Rothnie, Consultant in BuroHappold's Transport team, then explained the process of a Design Sprint, from understanding the topic and defining the problem to brainstorming and designing ideas to finally presenting it to the others.

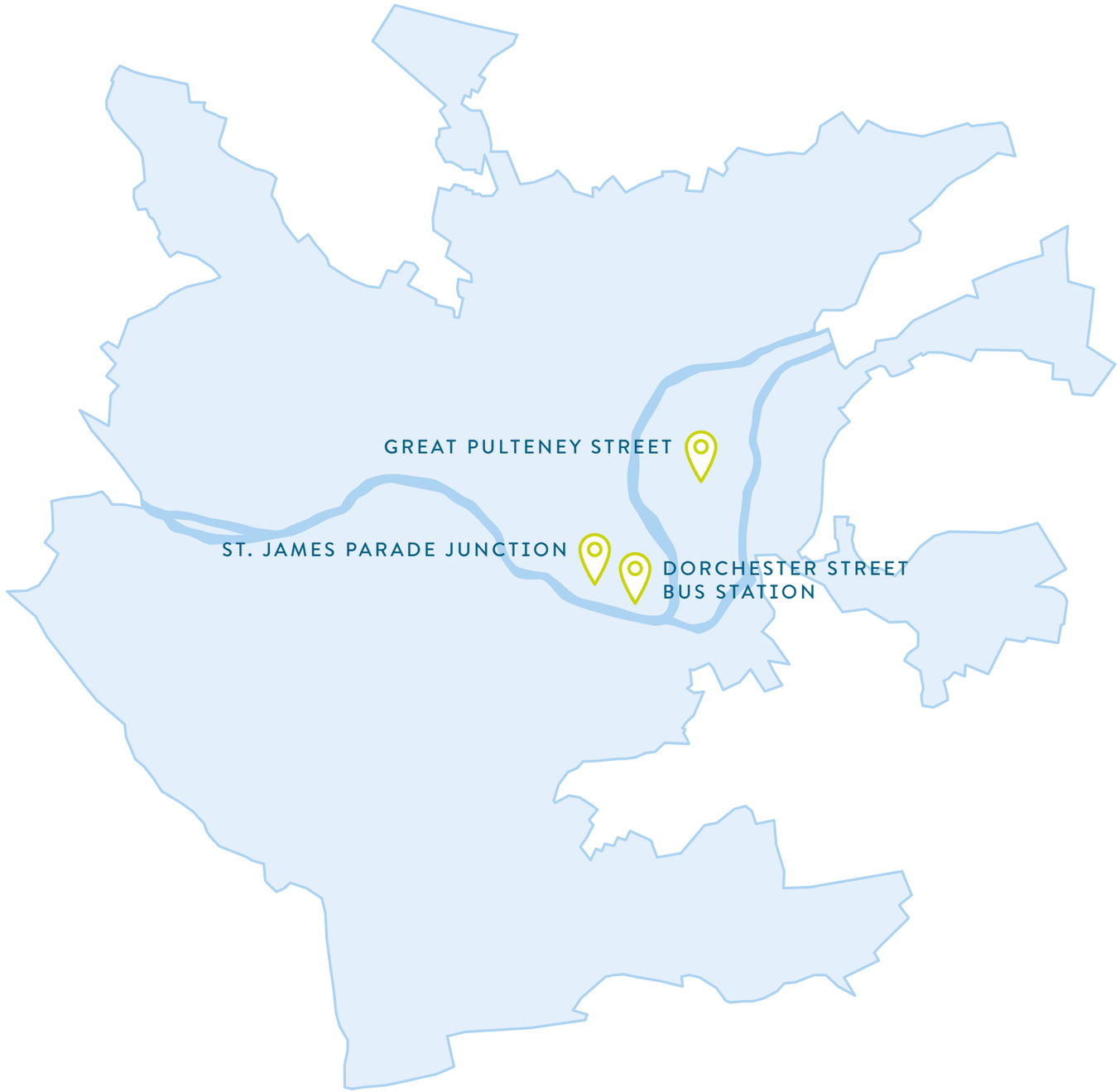
The twenty attendees consisting of BuroHappold staff and representatives from Grant Associates, Jones Lang LaSalle, The University of West England, and Ngenuity sprinted looking at three different sites in Bath: Great Pulteney Street is a picturesque thoroughfare with mainly residential land use surrounding it, and has street features including: wide lanes, on-street parking, roundabouts, cycle lanes and pedestrian crossings. Dorchester Street is a busy street with a bus station. It is sided by a colonnade. This street posed an interesting challenge with many buses pulling up along the bus stops outside the bus station throughout the day. Passengers waiting for these buses rest on benches outside the station, adding to the already busy pavement with many people passing through. Finally, St James Parade Junction is an interesting site to study as it has lots of traffic coming through from St James Parade and the Somerset St junction just before it. There are also cars entering and exiting an underground parking facility from this street.

Attendees at the Design Sprint followed the process to reach ideas for reclaiming the specific streets in an era of autonomous and connected vehicles. Ideas ranged from removing all of the lines and street furniture from a busy junction to open the space up to people and nature; turning the surface of a wide thoroughfare into a green area with sheep and autonomous sheep dogs(!); confining CAVs to one lane either side with allocated drop-off points; creating a street with two storeys with autonomous vehicles below ground and cyclists and pedestrians above ground; and creating new business opportunities for a busy street by replacing the traffic with trees and adding new retail units filled with cafes and shops to line the streets.

"Communication technology is changing our behaviours, automated vehicle technology will change our physical environment, I'm fascinated by the point where changes in behaviours and systems meet. Gaining a perspective on how different people in different cities see the potential impact of automated vehicles is very powerful and this sprint is a brilliant way of achieving that."

Gavin Thompson
Head of Energy Consulting,
BuroHappold

BATH : SITES


GREAT PULTENEY STREET
ST. JAMES PARADE JUNCTION
DORCHESTER STREET
BUS STATION

BATH : WHY HAVE WE CHOSEN THESE SITES?

GREAT PULTENEY STREET

This picturesque street sits between the center of Bath and the A36, but does not allow any traffic (other than buses and taxis) to travel directly between the two as Pulteney Bridge is inaccessible to general traffic. It is a residential street with wide pavements and parking on both sides. The roundabout is very wide and spacious with not much traffic passing through, there is also parking on the street corners adjacent to the roundabout. Great Pulteney Street is also a cycle route. This presents a good example to think about how CAVs might affect our roads in residential areas and roundabouts, and how the introduction of CAVs may lead to better connections between the A36 and the center of Bath.

DORCHESTER STREET BUS STATION

This busy street has many buses pulling up along the bus stops outside the bus station throughout the day. Passengers waiting for these buses rest on benches outside the station, adding to the already busy pavement with many people passing through. It is also rather unpleasant for pedestrians due to the emissions from the buses. The bus station has bays for many buses behind it, and these exit via the side of the station onto the busy street. The street also feeds into the junction with St James Parade, which many pedestrians cross to enter Bath city center and visit the high street shops. It would be interesting to think about how CAVs might affect the design of streets with so many bus stations, buses and pedestrians to take into consideration.

ST JAMES PARADE JUNCTION

This junction provides an interesting site to study as it has lots of traffic coming through from St James Parade and the Somerset St junction just before it. There are also cars entering and exiting an underground parking facility from this street. At the junction, traffic can turn into Dorchester Street; those coming from the other direction (mainly buses and coaches) must turn at the junction and enter the A367. The junction is very busy with pedestrians as it leads to the city center and shops. There is a triangular island which pedestrians can be stranded on when the lights change, and at the entrance/exit to the underground parking it is difficult for cars to move due to the flow of pedestrians. With CAVs, this junction could be completely different with regards to how the vehicles exit/enter the junction and interact with pedestrians.

2.1 GREAT PULTENEY STREET - TEAM 1

Andrew Scoones (Ngenuity), **Hannah Davy** (BuroHappold), **Imogen White** (BuroHappold)

Write-up by **Imogen White**

What is your team's idea?
We looked at Great Pulteney Street and the opportunities for reclaiming the street there. The main observation we made is that the wide road was little used by motorised vehicles and had therefore a lot of wasted space to accommodate the few vehicles traveling through. The idea we came up with was to move the road from the inside to the outside of the street and allow pedestrians and communities to reclaim the street and its Georgian features, such as the beautiful roundabout. As CAVs are able to use space more efficiently, a narrow CAVs only one-way lane on either side of the street would be sufficient. Small laybys would create a wave-like boundary between the outer vehicle lanes and the inner pedestrian and cycling street. The inner street was imagined to consist of two one-way cycle lanes, where each lane was separated by a large strip of open space, which would be the main focus of the street. This would be planted over, with community gardens, scenery and some farm animals, such as sheep.

Our main technological ideas around this vision were that the pedestrians, animals, cyclists and cars would all be on one single surface made out of an interlocking grid. CAVs are a lighter vehicle, which makes this a real possibility. The grid would include technology to measure footfall and use. Vegetation and grass could grow through this grid, allowing for a green surface. However, the grid would be denser where the CAVs drove and the least dense where the gardens and sheep were. The changing surface strength could simply be provided by fewer or a greater number of sections placed down to increase or decrease the grid density. This allows future flexibility as it would be very easy to remove the road if the zone became car free in the future, and extend the garden, by simply removing some of the grid system to allow more breathing space for vegetation. It would also provide an interesting aesthetic and the feel that the street was fully integrated into nature.

Further practicalities considered were to move the current residential on street parking to the back of the houses, as well as incorporate a lane for all services (e.g., delivery, bin collection units) at the back. Natural barriers of hedges, stones and/or living woven willow fences could provide division between users if necessary, such as between cyclists and pedestrians.

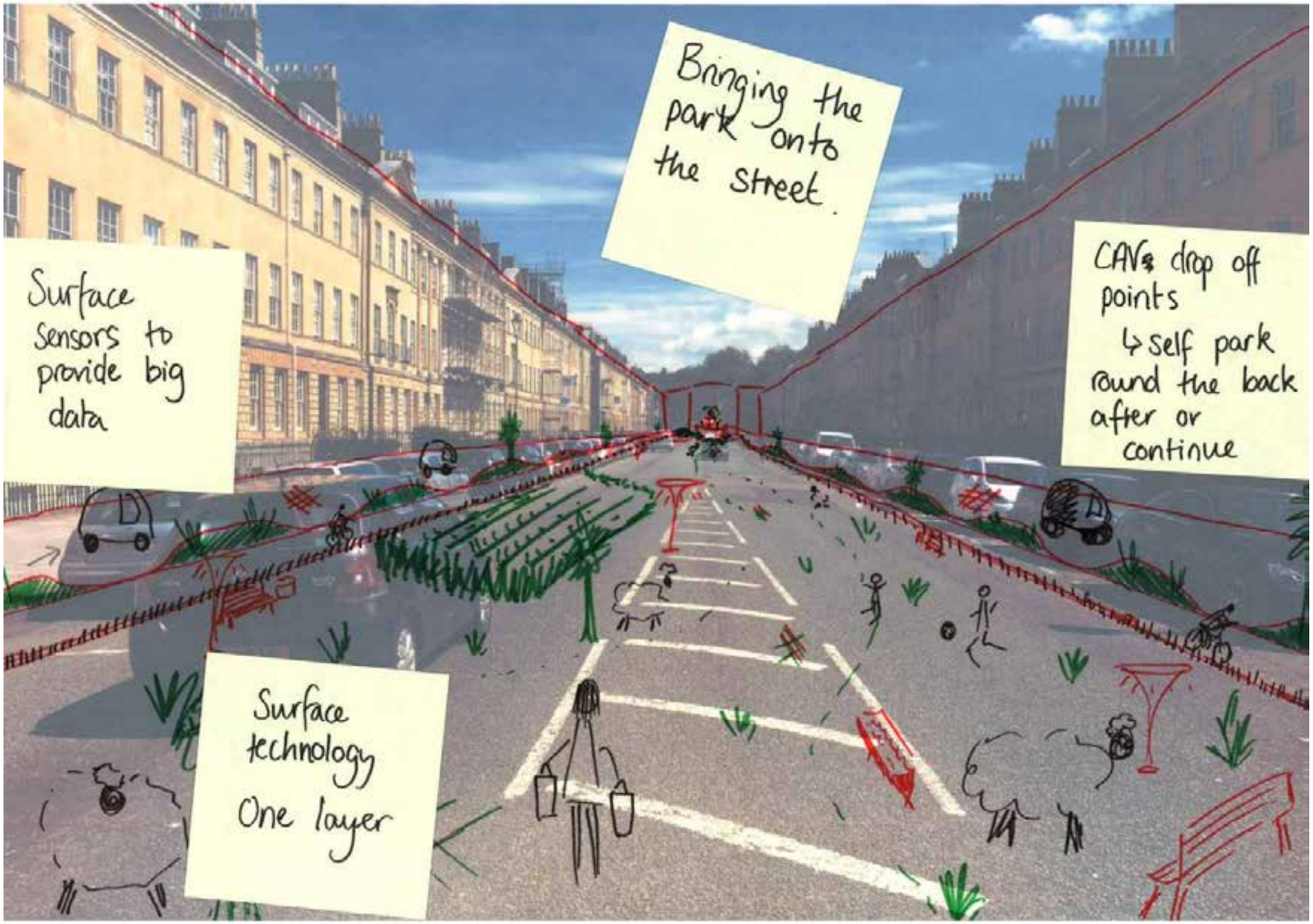
Why is this a good idea for your city?
This is a good idea for Bath as it encourages communities to get together. It provides a green route from the centre to Sydney gardens and makes better use of the space. The idea of having sheep grazing revolved around linking the city back to the surrounding countryside, and making sure all landscaping had a practical function. It also promotes cycling and walking as well as fostering happiness for commuters as they get to witness more nature within the city centre. It should encourage shared CAV use and the harmony between multiple user groups. Lastly, it moves on from being a street to get you from A to B to being a landmark, where you can pause and rest, feed farm animals, and admire the Georgian buildings that surround the space.

What would need to happen to implement your team's idea?
To implement the idea, a research project on the fluid surface technology would need to be undertaken. Some ideas were sketched around ensuring that the strength, flexibility, and drainage of the product was successful, whilst providing space for plants to thrive. It would also require a cultural shift that embraces the sharing of vehicles and promoting community spirit.

"Whilst I appreciate the environmental benefits that CAVs can bring to the urban environment, I am yet to be convinced that they can disrupt the old fashioned psychological relationship between citizens, transport the city and a sense of 'freedom of movement' with anything other than a nightmarish totalitarian vision. These workshops are really helpful for testing such thinking."

Andrew Scoones
ngenuity Ltd

2.1 GREAT PULTENEY STREET - TEAM 1



2.2 GREAT PULTENEY STREET - TEAM 2

Conor Hubert (BuroHappold), **Emily Huynh** (BuroHappold), **Oliver Renton** (BuroHappold), **Storm Hayward** (BuroHappold)

Write-up by **Storm Hayward**

What is your team's idea?
Our team came up with an idea for Great Pulteney Street. In our initial discussions, we all agreed that Great Pulteney Street is currently not being used to its full potential: a wide road with minimal traffic. The street consists of great architecture and so we felt that it would be best to remove the road entirely from street level and reclaim the space for pedestrians and cyclists.

With the presence of vaults below street level, we believe it would be feasible to build a tunnel the length of Great Pulteney Street to provide access for CAVs. Inside the tunnel there would be two lanes of traffic going in opposite directions. These lanes could be minimal width due to CAVs being able to follow a precise line and having vehicle-to-vehicle communication as well as vehicle-to-infrastructure communication. There would also be a space underground, underneath the fountain area, where CAVs would be stored and charged.

Great Pulteney Street would also serve as an information point for CAVs with information and rental hubs dotted along the street. Commuters would purchase tickets via an app to hop on and off CAVs. Those without a smartphone could purchase single or multiple trip tickets at the rental hubs. The use of this area as a CAV rental point would further encourage more people to utilise this street space. To ensure that people sharing a CAV feel save, there would be a 'friends' network' that allowed individuals to create a group of people with whom they would be happy to share a CAV. This would, for example, be particularly useful for young children when travelling to school.

Moving the road underground would remove the need for road markings, parking and roundabouts. Bath is a beautiful city and to attract more people to the area we decided to populate street level with gardens, a pond, and water features. Currently, Great Pulteney Street is generally quiet and we wanted to create a space for people to come and relax. With the Rec rugby ground being adjacent, Great Pulteney Street is a major access route on match days and so a pop-up food market would create a centre for people to congregate. Food markets have proved very popular in Bath over the years and we felt that it would also be beneficial to have a weekly farmer's market.

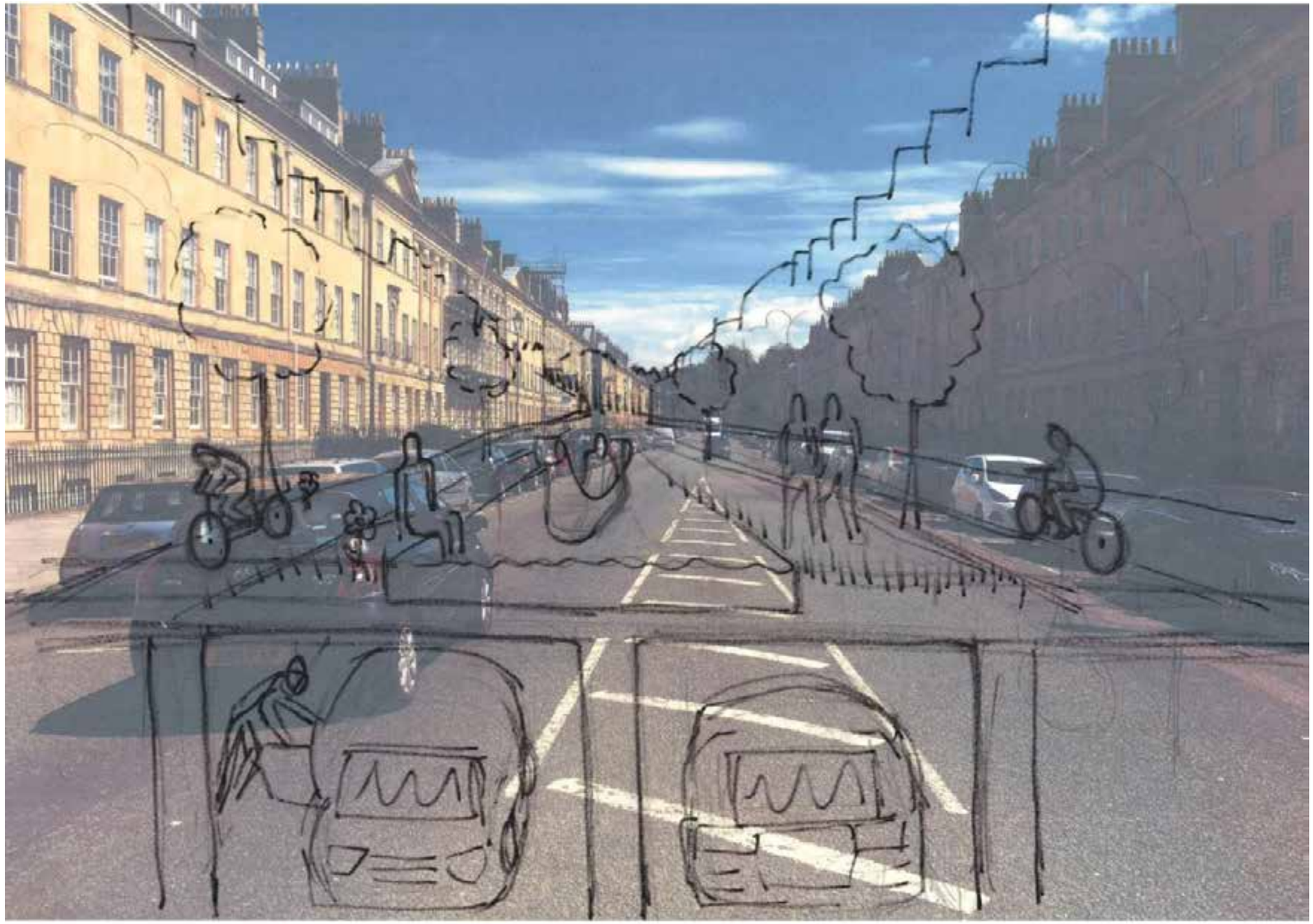
Why is this a good idea for your city?
Bath is a very touristy city and the inner city is hugely congested with few places to stop and relax. Great Pulteney Street is a major architectural attraction and is currently not celebrated as much as it should be. Public transport in Bath is hugely expensive and not very reliable. The usage of CAVs would aid travelling around the city as and when needed and ride sharing could also reduce the cost to make it more affordable.

What would need to happen to implement your team's idea?
To initially implement this idea, surveys would need to be conducted to verify whether the ground is suitable for a tunnel and whether this would have too much settlement impact on the surrounding buildings and structures. Design would need to be carried out to smoothly integrate the tunnel with the roads on either side of Great Pulteney Street. Gaining public trust will be a big issue when initially implementing CAVs and so events would have to be held to prove the safety and advantages of CAVs.

"The design sprint was a fantastic way to explore the future of CAVs; by bringing together people from different specialisms and grades it encouraged an environment from which creative ideas could flourish and be explored together."

Emily Huynh
Engineer in Sustainability and Physics,
BuroHappold

2.2 GREAT PULTENEY STREET - TEAM 2



2.3 ST. JAMES PARADE JUNCTION - TEAM 1

Antoine Dao (BuroHappold), **David Betts** (BuroHappold), **Likhitha Nalli** (BuroHappold), **Mithun Thekkumbadan** (BuroHappold)

Write-up by **Antoine Dao**

What is your team's idea?
We focused on the possibilities of infrastructural change offered by CAVs in the mid/long-term future. We aimed to provide a vision piece flirting with sci-fi where construction cost and behavioural barriers to change are non-existent thus enabling a freer approach to this design sprint.

Our current approach to road infrastructure is that there is a need for specific properties to appear in order to ensure safe driving by humans. This includes delimitation such as pavements to mark the difference between pedestrians and vehicles – and sometimes cyclists; direction such as road signs to direct the flow of traffic; and regulation such as road lights to regulate the flow of traffic. Our assumption is that by 2050 CAVs will be fully implemented on highways, some cities and manually driving cars will become a luxury sport reminiscent old traditional ways much like horse riding or hunting. Under this scenario, street clutter will be no more! Pavements are replaced by dynamic LED lighting systems (or VR changing the distribution of pedestrian, cycle and vehicle road according to traffic/ events; streets signs will be dismantled as on board GPS systems and smartphones will direct CAVs and pedestrians respectively. Regulations such as left hand side priority will be a notion of the past as CAVs are detected and can coordinate their movements to cross each other like a well-organised military platoon.

Why is this a good idea for your city?
These infrastructure changes will promote the following outcomes:

- Space liberation: CAVs do not need to be parked, they can simply pick up, transport and drop off users, and repeat the cycle again without need to stop and take up a fixed place. This dynamic use of transport assets will liberate a significant amount of space currently locked in parking. Cars will be liberated and can be used for other purposes. Arguably some of that space will be repurposed for vehicle charging (oh, did we not mention all cars are electric by then?)

- Flexible spaces: the benefit of an LED based delimitation system is that it makes street space fully flexible and adaptable meaning traffic/ pedestrian space can be changed for a rush hour configuration, a street party setting or for emergency vehicle access.

- Optimised public transport: one of the main barriers to public transport is the infamous "last mile" which creates a large enough transport gap to discourage a wider range of users from using public transport. This is mainly the case in suburban or rural areas, which have less-well developed public transport networks. Promoting CAVs means this last mile can be bridged by sharing vehicles with people going in a similar direction (much like Uber pool nowadays). Furthermore, it is possible to imagine CAVs replacing buses and taxis completely.

- Increased safety: removing the human element from driving is predicted to add an element of safety to the public realm. The flexible LED system also promotes this as we can perfectly imagine creating safer configurations on school routes at times of use, dynamically generating cycle lanes when needed and making zebra crossings appear wherever needed. Furthermore, the full digitization of this street system requires constant monitoring which will create an invaluable bank of information to be analysed by machine learning software to further optimise and increase the safety of the system.

"It was interesting to hear and contribute some diverse views on a reimagined Bath of the future. The question is would Bath really be the place to embrace such radical change?"

David Betts
People Flow Analyst in Smart Space
BuroHappold

2.3 ST. JAMES PARADE JUNCTION - TEAM 1

2.4 ST. JAMES PARADE JUNCTION - TEAM 2

Danny Nagle (Grant Associates), **John Parkin** (University of the West of England), **Jon Foley** (BuroHappold), **Neil Harvey** (BuroHappold)

Write-up by **Neil Harvey**

What is your team's idea?
Our idea stems from the desire to both improve the safety of pedestrians within the public realm and to improve and control vehicular flows through our city centres. City centres are often plagued by stop-start traffic, caused by pockets of congestion and chains of traffic signals and demand crossings. This creates frustration on the part of the driver, regimented crossing points for pedestrians, uncertain journey times, unpredictable traffic speeds and inefficient energy use of the vehicles as well as increased pollution.

The evolution of CAVs gives cities the opportunity to take more control of vehicle speed within its boundaries and to apply limits based on the category of the public realm, the number of pedestrians at that particular time of the day and the volume of vehicular traffic. We thought that in areas of high pedestrian movements the vehicles should generally be restricted to pedestrian walking speed. It was felt that a journey through a city centre at constant walking speed would take a similar time if it had to constantly stop and start through traffic signals and general congestion. The pedestrians could then simply weave through the traffic, as its flow would be low and very predictable. GPS guidance in the vehicles would know what limits have been set throughout the city and so would naturally decide on alternative routes if they were quicker, so a natural balancing of traffic would occur through this flexible speed limit setting.

We wanted to understand what would change in the streetscape as CAVs were introduced. We first cut out all street furniture and clutter that would no longer be required, removed kerbs and then identified where traffic may run within the now quite generous public realm corridor. It was felt that traffic would still be restricted to lanes still on streets, with speeds slightly higher than in the shared pedestrian zones. When the traffic however reached the shared pedestrian zones it would slow down and fan out to mingle with the pedestrian flows. This would allow for a similar overall flow of traffic through the network without creating bottlenecks. The image shows the approximate comfortable stopping distances of the vehicles and how they reduce their speed in the areas of high pedestrian activity.

Why is this a good idea for your city?
As there are too many cars, too many signals, and too many pedestrians, currently a compromise for all users at the major conflict areas.

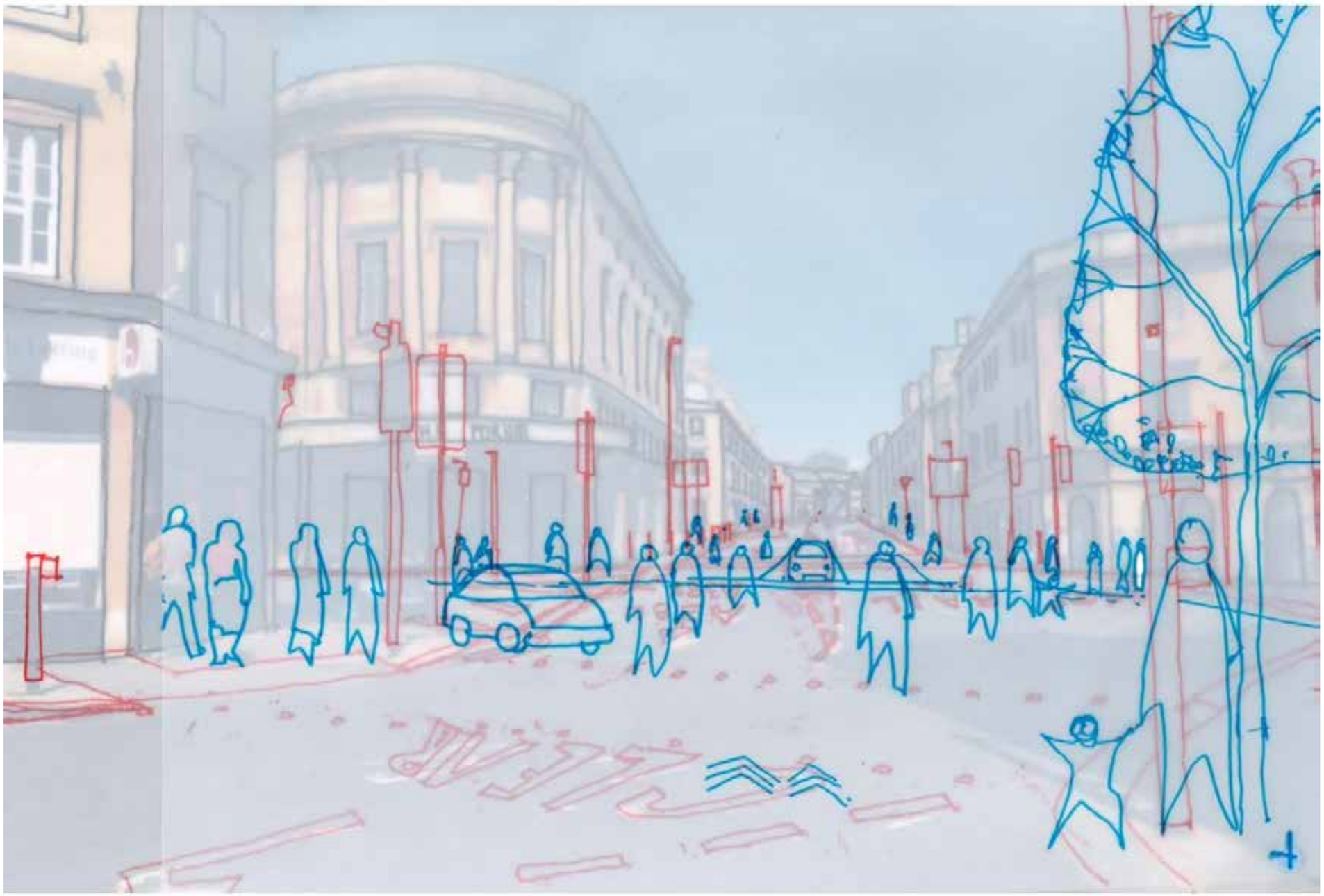
What would need to happen to implement your team's idea?
We see this being a staged rollout:

- Review of city centre low speed variable limits effect on network (now)
- Policy change and VMS introduced (4 years)
- With uptake of speed limiter in vehicles, only vehicles with this tech allowed in cities so that limits can be enforced (8 years)
- With the full uptake of CAVs the streetscape can be changed, junctions removed, kerbs removed and the full solution implemented (15 years)

"Critically important decisions need to be made about how we introduce autonomous vehicles into streets and cities. The overarching principle should be that they are used eliminate the adverse effects of noise, pollution and risk resulting from the current domination of the motor vehicle."

John Parkin
Professor of Transport Engineering,
University of the West of England

2.4 ST. JAMES PARADE JUNCTION - TEAM 2



2.5 DORCHESTER STREET BUS STATION

David Roberts (Jones Lang LaSalle), **Gavin Thompson** (BuroHappold), **Robert Moyser** (BuroHappold)

Write-up by **Robert Moyser**

What is your team's idea?
Our team focused on Dorchester Street bus station with the broad idea to undertake the following interventions:

- Take out the bus drop off and bus terminal: Buses fulfil a similar pick up and drop off type service that a CAV might do as part of a broader mobility as a service offer. In contrast to a bus, CAVs are however more flexible in providing an on demand service. We therefore see a bus network as becoming superfluous once CAVs are fully deployed. Hence, we see the opportunity to repurpose existing city owned assets that relate to bus use. The bus station, for example, could be replaced by a higher yielding land use such as retail and residential.

- Ban cycling from the street: For CAVs, software will control speed in a predictable way. The speed of cyclists remains however unpredictable. In a CAV environment, where vehicle speeds are lower and movement is more predictable, bikes may become more of a nuisance as they would stop the movement of CAVs. It is therefore recommended that cycle-only streets are created within the city to minimise any conflict between the different modes.

- Introduce green infrastructure within Dorchester street: As vehicle speeds and vehicle numbers are reduced on the street, there is an opportunity to increase the use of green infrastructure to support an enhancement of the public realm.

- Provide greater retail activity at street level: As highlighted above, a transformation of the bus terminal highlights the opportunity to switch lower value land use to more profitable land uses from a city perspective, greatly enhancing the Mainline Rail Station as a Transit Orientated Development.

- Improve ICT infrastructure connectivity: CAVs will require enhanced ICT infrastructure to support movement around the city. Currently cellular connectivity outside most of the major cities is not comprehensive, therefore cellular and/or a 3D Lidar map of the city (as used by Google) might be required. In addition, ICT infrastructure to support an enhanced public realm will also be required. Free Wi-Fi is one such example.

- Repurpose the existing Westgate below ground car park as CAV drop off, storage and charging: As car ownership declines with CAV take up, the number of required car parking spaces in a city will be less. At grade car parking can be easily repurposed. However, below ground car parks that are either standalone or integrated with a development (like Westgate) are harder to repurpose. It is recommended that those below ground car parks are utilised as direct drop off to CBD locations (noting that lobby facilities would need to be retrofitted). They should also be utilised as CAV storage, maintenance areas, and charging facilities.

Why is this a good idea for your city?
The above-developed interventions will have environmental benefits such as noise reduction, improved air quality, and improved lighting. By improving the public realm and creating new commercial nodes, the interventions also promote economic development and increase land values. In addition, we believe that our idea will provide taxi-like convenience for a fare of a bus and increase transit accessibility and capacity.

What would need to happen to implement your team's idea?
The following steps would need to be considered to implement our proposal:

- Chose a test site: Test site would need to be relatively restricted to ensure that interfaces with public services would be minimized. This would ideally be somewhere like Bath University, parts of the cities that offered two fixed destinations such as a park and ride or large multi-storey car park and a key node within the city. Potential users of the pilot should be brought into helping designing the scheme.

- Existing policy would need to be updated both in term of technical specification, but also insurance, personnel safety, security to take into account impacts of a CAV failure during the test.

- It would be recommended that an on demand service like Uber, halo, lyft be introduced into the city so that the general public can start to appreciate mobility on demand services.

- Clear statement of objectives and measurement of success would be required during the pilot to inform potential upscaling of the pilot.

- Introduce CAV manufacturers to take part in the pilot – utilising local universities as a key focal point of research.

- Look for sponsorship of the pilot to offset some of the CAPEX and OPEX of the pilot as well as seed funding from the transport catapult/ Innovate UK etc.

- Once the pilot has been deemed a success, a clear business model would need to be created to identify potential for citywide implementation.

- Finally, the system needs to be designed, procured, built, deployed, and operated.

"The design sprints are an excellent tool to explore opportunities and challenges of any intervention into the built environment. CAVs are rightly receiving a lot of attention at the moment, however, the design sprints have highlighted that coordinated thinking is required. I call upon city leaders to encourage open debate with stakeholders to ensure that we can maximise the benefits of CAVs for our cities"

Robert Moyser
Director Urban Futures, BuroHappold

2.5 DORCHESTER STREET BUS STATION

PITTSBURGH : NOVEMBER 21 2016

3. PITTSBURGH SPRINT

Shortly before we published our Global Design Sprint brief in mid-September, Uber announced the first self-driving Ubers on Pittsburgh's streets. This got us naturally excited to organize a Design Sprint there. When the Green Building Alliance saw our brief and approached us, we could have not been more excited. In Envision Downtown we quickly found another partner and our host for the event. Outside of California, Pittsburgh is THE city when it comes to autonomous and connected vehicles. In 2015, Uber and Carnegie Mellon University (CMU) set up a strategic partnership that included the creation of an Advanced Technology Center (ATC) near the CMU campus. Adding to the moment, the City of Pittsburgh and the American Architectural Foundation announced in October 2016 the convening of a national summit on design and urban mobility to take place in May 2017. What better time and place to bring together the technology side with the urban planning side in the city where it all happens?

As the question of how we can reclaim and reimagine our streets in an era of autonomous and connected vehicles was more urgent than in our other cities, we selected three quite different sites – all of them however representing a typical street in Pittsburgh. The junction of Carson Street and 25th Street represents the historic business district, challenged by through-traffic and a relatively high number of pedestrians. Fort Duquesne Boulevard is a ten-lane road separating Downtown Pittsburgh from the Allegheny River. Perhaps nowhere else in Pittsburgh is there more potential to dramatically shift from a car-dominated to a people-first space. Finally, the intersection of Walnut Street and College Street in Shadyside represents a typical residential neighborhood that is considered 'walkable'. However much of the street is still double-loaded parking and two-way traffic.

The Pittsburgh Sprint was attended by policy researchers, computer scientists, engineers, urban designers, government representatives, transport planners from Pittsburgh. They were complemented by a few sprinters from other US cities including Washington D.C., New York, and Chicago. We kicked-off the Sprint with introductions by Ray Gastil, Director of Pittsburgh City Planning and Bryan Salesky, former Director of Hardware Development Self-Driving Cars at Google and now CEO of Argo AI. With the view from planning and technology in mind, our sprinters put together their minds in small groups to reclaim the streets in Pittsburgh.

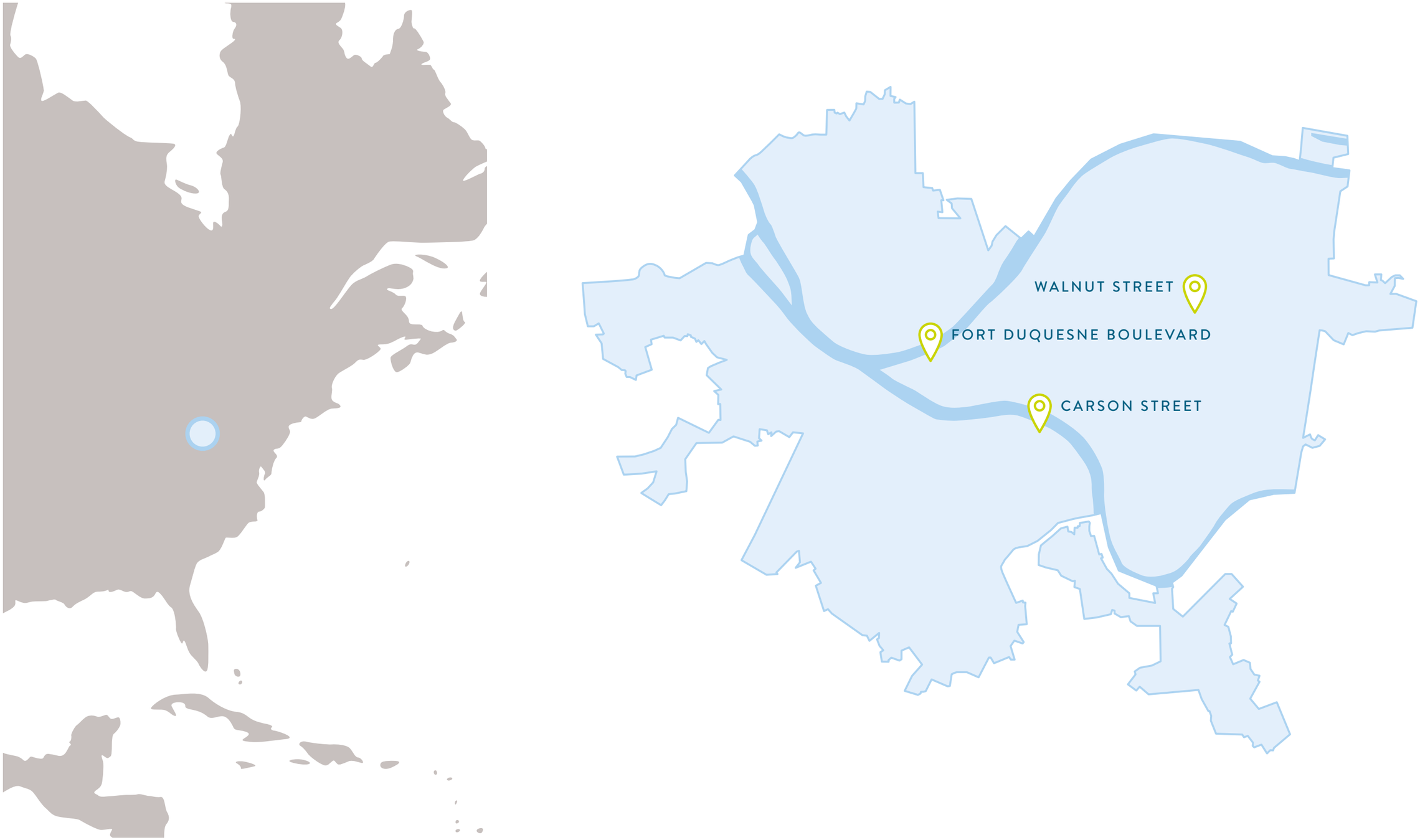
Ideas showed that urban designers challenged the views of those with expertise of the vehicle technology and vis-versa. One group created a "CARE zone" that would move away from today's "CAR zone" and create a highly pedestrianized zone in the Walnut Street residential area. Another group aimed to transform East Carson Street into an urban boulevard and to redesign side streets into a network of green streets focused on pedestrian trails. It became rapidly clear that there is great potential to make Pittsburgh more walkable and bikeable – and less car-dependent. The presentations sparked an interesting debate about the political, financial, and cultural challenges laying ahead. There was, for example, a lively debate around the benefits of continued investment in mass transit such as Bus Rapid Transit (BRT) systems versus the replacement of public transport with fleets of shared autonomous vehicles.

We would like to thank our collaborators Green Building Alliance and Envision Downtown for helping to make this Design Sprint happen and Envision Downtown for hosting it.

"It was not only great fun, it also helped me as someone working on the technology, better understand the concerns and expectations from the design and planning community. It is rare to have researcher from the robotics team talking to urban designers and landscape architects – but it is absolutely necessary if we want to create better cities."

Bryan Salesky
CEO of Argo AI

PITTSBURGH : SITES FOR STUDY



PITTSBURGH : WHY HAVE WE CHOSEN THESE SITES?

FORT DUQUESNE BOULEVARD DOWNTOWN

Ten lanes of traffic separates Downtown Pittsburgh from the Allegheny River; it is no surprise that Downtown has gradually turned it's back on its northern front. Perhaps nowhere else in Pittsburgh is there more potential to dramatically shift from a car-dominated to a people-first space.

CARSON STREET EAST CARSON

A historic, iconic street in Pittsburgh's South Side that is similar to many business districts throughout the U.S. – with one main street full of businesses and residential buildings just off the main drag. The street has a number of pedestrians as well as traffic that is passing through on the way to other destinations. The challenge of adapting such a street to autonomous vehicle use can be extrapolated out to not only other towns in other states but also to many other business districts within Pittsburgh. The potential for reclaiming parking lanes, adapting traffic flow, ensuring safe crossing for pedestrians, and potentially designating pick up and drop off areas or charging for electric vehicles may all be part of it.

WALNUT STREET & COLLEGE STREET SHADYSIDE

Walnut Street runs east west through Shadyside linking a residential community to a dense retail corridor. It contains one of the most iconic shopping streets in Pittsburgh and has helped redefining Shadyside as 'walkable'. However, much of this street is still double-loaded parking and two way traffic, posing great challenges for mobility. The corner at College Street has a mix of single and multifamily housing. In all of this, it is representative for many residential streets in Pittsburgh – and across the U.S.

3.1 FORT DUQUESNE BOULEVARD - TEAM 1

Christine Mondoor (evolveEA), **David Onorato** (Pittsburgh Parking Authority), **Elizabeth Okeke-Von Batten** (American Architectural Foundation), **Justin Miller** (City of Pittsburgh), **Sean Luther** (Envision Downtown)

Write-up by **Sean Luther**

What is your team's idea?
Ft. Duquesne Boulevard in Downtown Pittsburgh is a vehicle priority arterial serving as the major connector between the CBD and Pittsburgh's North Hills (Parkway North/I-279), South Hills and Airport corridor (both via Parkway South/I-376). Because of its existing role as a regional connector street, Ft. Duquesne Boulevard has the unique opportunity to transform into THE transition point between future autonomous vehicle trips (passengers and cargo) from the region and a future pedestrian priority downtown core. Ft. Duquesne works in a series of parallel streets with Liberty and Penn Avenues (extremely rare for Downtown Pittsburgh given its colliding street grids). The opportunity to pivot Ft. Duquesne into an autonomous vehicle transition corridor is magnified by planned transit improvements on Liberty Avenue (reducing the demand for transit service on Ft. Duquesne) and frees Penn Avenue to continue to focus on pedestrians and people on bikes. By shifting priority on Ft. Duquesne to autonomous vehicles, the overbuilt existing cross section can be reduced from the current six-lane configuration. The reduced street width allows for stronger and safer pedestrian connections between the CBD and Cultural District to the adjacent Allegheny Riverfront. Some street space can also be re-allocated to provide significantly larger sidewalks on the southern side of the boulevard to better serve passenger pick-ups and drop-offs. Expanded sidewalks will also assist necessary efforts to increase the complexity of adjacent facades and introduce retail and service businesses oriented towards arriving and departing downtown patrons.

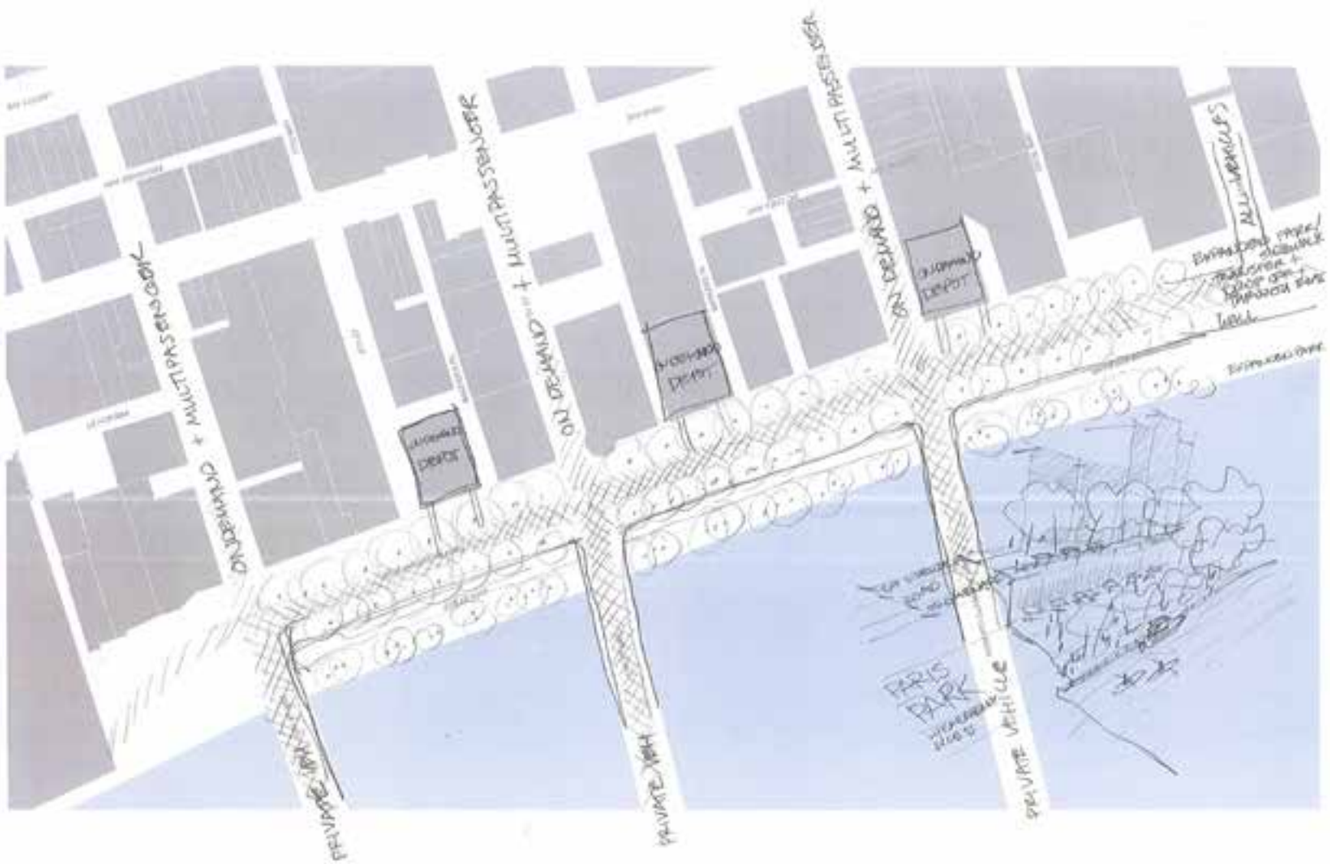
Why is this a good idea for your city?
Ft. Duquesne Boulevard's new role as a hub for autonomous vehicles provides an opportunity to use demand pricing for curb access to assist with emerging transportation demand management efforts in Pittsburgh's CBD. Passengers will be incentivized to avoid peak commuting hours by pricing curb access lower before and after Pittsburgh's traditional rush hour periods. Cargo deliveries will also be incentivized to avoid busy morning and afternoon hours by a similar pricing strategy. Parking garages on Ft. Duquesne offer an additional infrastructure asset to mitigate the potential "war for the curb". As the demand for individually owned passenger vehicles drops with the introduction of a shared system of autonomous vehicles, the first floor of these garages can be repurposed to serve as an "on demand" depot for Downtown Pittsburgh. These new depot spaces will serve as gathering places for shared ride trips (ex. Uber Pool) and vehicle charging/layover spaces to keep the street itself free for continuous use. Importantly, the repurposed garage space can also provide space for personal package delivery and storage (Amazon, groceries, etc.) to further remove the majority of delivery vehicles out of the core of downtown.

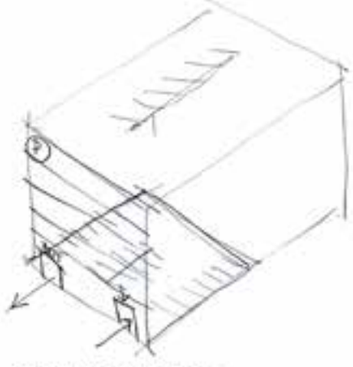
What would need to happen to implement your team's idea?
Implementing a plan for Ft. Duquesne's future role as an autonomous vehicle hub for Downtown Pittsburgh will require explicit coordination between the Pittsburgh Cultural Trust (integrating the operation of Ft. Duquesne into their large planned development between 7th and 9th Streets), the Public Parking Authority of Pittsburgh (owner/developer of many adjacent parking garages, implementation of "on demand depots"), and other adjacent property owners. The technical implementation of the new roadway system will fall to the City of Pittsburgh and better connections with the high-occupancy vehicle lanes on the Parkway North (a potential major autonomous vehicle corridor) will require coordination with PennDOT. Above all, a community vision, driven by the Pittsburgh Cultural Trust, the Pittsburgh Downtown Partnership and Riverlife Pittsburgh alongside political leadership by the Mayor and County Executive are the keys to ensuring this dynamic future structure for Ft. Duquesne Boulevard becomes a reality.

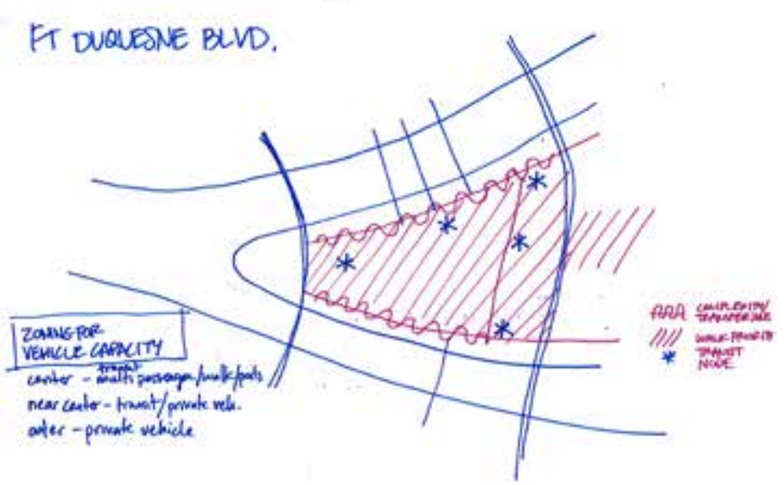
"Our productivity and creativity as a team blossomed due to the constraints of time and scope, and reviewing the final results from each team activated further thinking about how to apply the proposed interventions to a larger city system. I loved the experience."

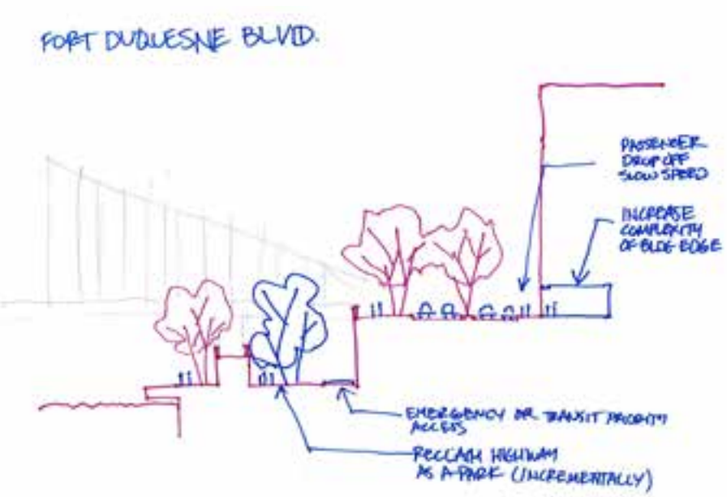
Elizabeth Okeke-Von Batten
Director, Center for Design & the City,
American Architectural Foundation

3.1 FORT DUQUESNE BOULEVARD - TEAM 1









3.2 FORT DUQUESNE BOULEVARD - TEAM 2

Brooks Robinson (Pittsburgh Cultural Trust), **Chris Osterwood** (Robotics Institute, Carnegie Mellon), **Greg Cerminara** (Michael Baker), **Nicholas Chubb** (City of Pittsburgh)

Write-up by **Chris Osterwood**

What is your team's idea?
Our team focused on reclaiming the ten-lane Fort Duquesne Boulevard which separates Pittsburgh's downtown from one of the city's biggest assets, the Allegheny River. The road is currently dominated by relatively fast vehicular traffic with a tree-lined spine in the middle. To access the green spine, pedestrians however have to cross several traffic lanes and can do that only at intersections. On the side of the river, there is a walkway at a lower level. From the downtown Pittsburgh side, it is however somewhat hidden. Our team thus aimed to bring pedestrians closer to the real estate on one side of the road and the river on the other side.

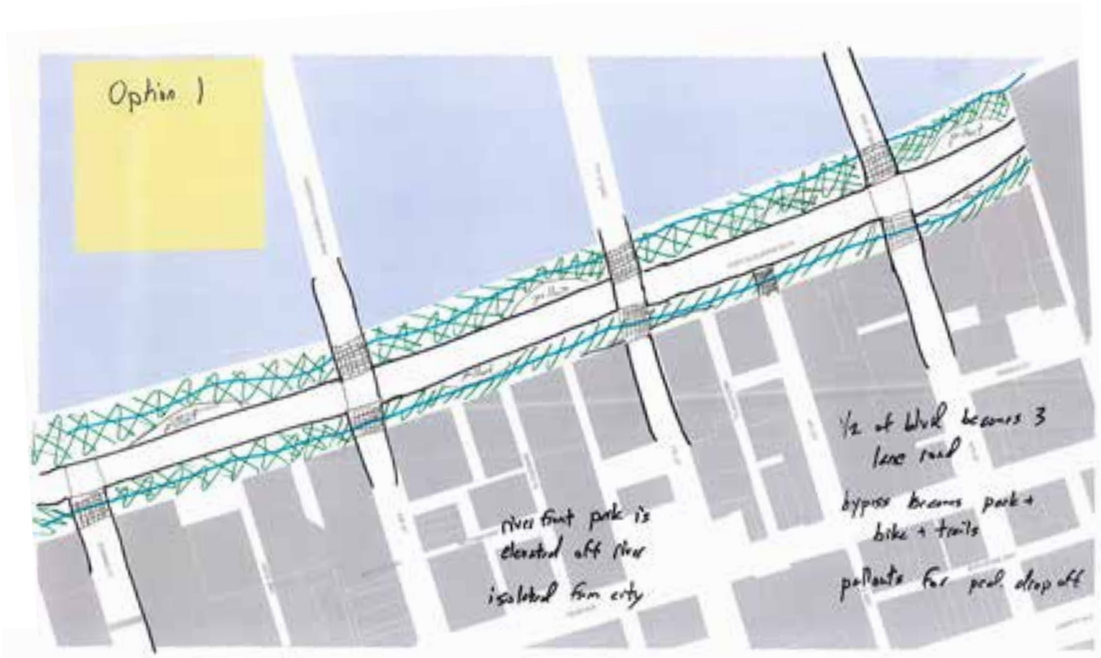
Assuming that there will be dynamic lane direction and smart signalling with the introduction of connected and autonomous vehicles, we came up with two options to achieve our goal. Option 1 would reclaim four lanes on both sides of the boulevard, leaving two lanes for vehicles in the middle – therefore flipping the roads with the current green middle spine. This would drastically reduce the distance to cross from one side to the other, providing pedestrians the opportunity to stroll along the shops on the downtown Pittsburgh side or walk along the river. Option 2 would leave the lower walkway along the river and reclaim eight lanes of the street on the downtown Pittsburgh side, providing pedestrians a grand boulevard along the downtown Pittsburgh side.

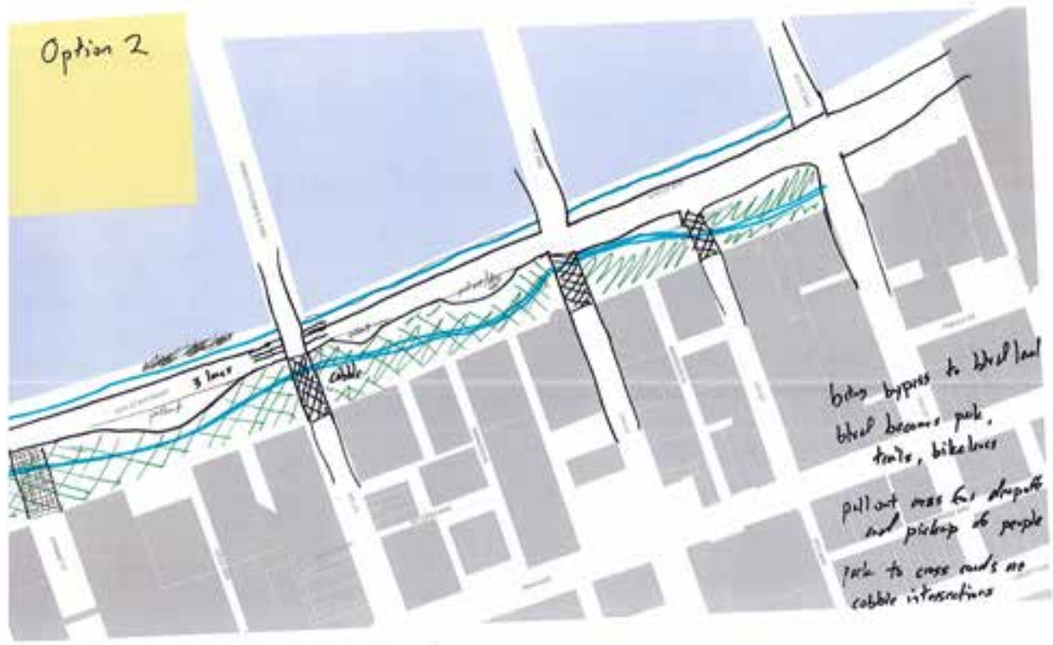
In both options, there will be pull off areas for CAV drop off and pick up. The cross roads coming from the bridges would be made with cobblestones to calm the traffic and signify that the area is for pedestrians.

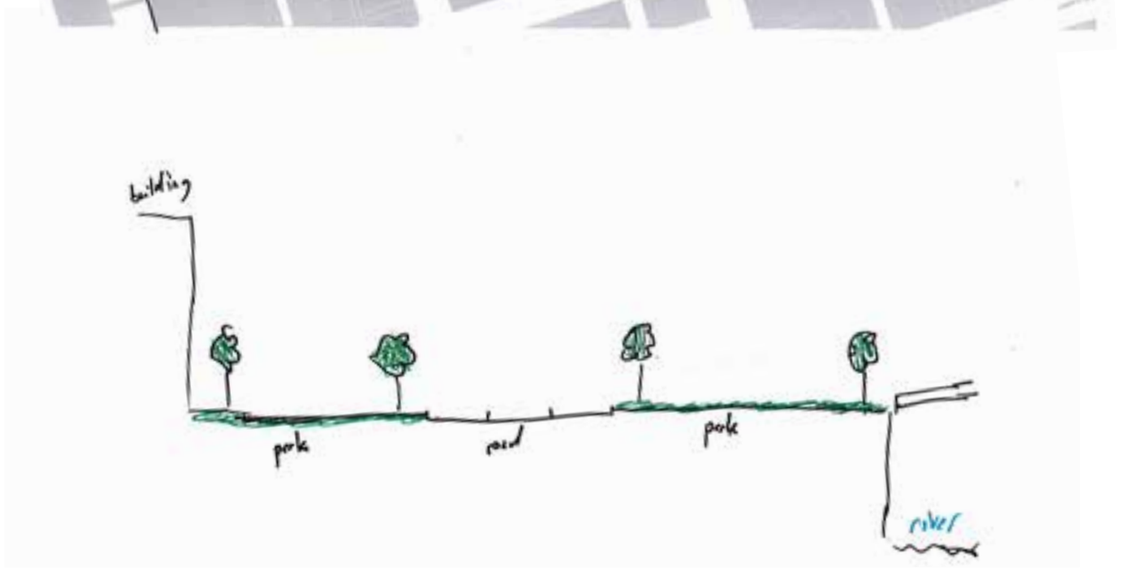
Why is this a good idea for your city?
We believe that creating a more pedestrian friendly environment along the downtown Pittsburgh side will drastically increase land values as shop frontages will be better utilized. In addition, there are environmental benefits as there will be less traffic and more green space, leading to improved air quality. Both options will improve the pedestrian and bike connectivity to the rest of the city.

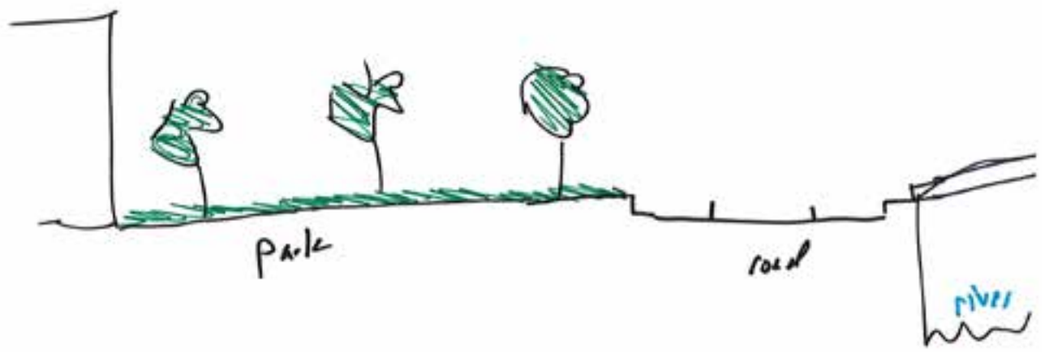
What would need to happen to implement your team's idea?
To implement either of the options above, we suggest a public-private partnership for construction and maintenance. This could, for example, be between the shop owners on the downtown Pittsburgh side who will likely benefit from the increased land value and the City of Pittsburgh.

3.2 FORT DUQUESNE BOULEVARD - TEAM 2









3.3 WALNUT STREET - TEAM 1

Bryan Salesky (Argo AI), **Kristen Osterwood** (Green Building Alliance), **Michael King** (BuroHappold), **Neil Kittredge** (Beyer Blinder Belle), **Ray Gastil** (City of Pittsburgh)

Write-up by **group**

What is your team's idea?
Our group developed a CARE zone concept inspired by the urban context of the site, in which Walnut Street is the retail "high street" for the Shadyside neighborhood, a well-defined 90-block residential district surrounded by high-volume avenues. Because of its clear urban form and residential character, the neighborhood is a perfect test platform for a Connected Autonomous Residential Experience zoning overlay – a "CARE zone" – replacing the existing condition of a "car zone" that resulted from 20th century technology. Shadyside will become a replicable model for other residential communities around the city – ultimately leading to a series of CARE zones connected by a citywide mobility web.

Streets and public spaces within the CARE zone are radically redesigned to favor connected autonomous vehicles (CAVs) and transform the pedestrian and mobility experience for area residents. Legacy vehicles are permitted within the zone, however upon entering the CARE zone, human drivers are notified of special driving and parking restrictions, which greatly reduce speeds and eliminate street parking to create a highly pedestrianized and safe public realm. Street parking would however still be allowed on the side streets. The zone permits traffic and vehicle ownership patterns to be mixed, while enabling the transition to CAVs over time and allowing residents to experience the quality of life benefits of a CAV-oriented community.

Notwithstanding the larger issues of autonomous vehicles (safety, equity, traffic, policy, technology, rollout), we explored the spatial implications of streets given over to connected autonomous vehicles. A world of CAVs would require less space for parking, less space for errant vehicles, and potentially less space per vehicle. Considering the significant problem of the combined sewer overflow (CSO) in Pittsburgh, our street design aimed to manage all rainwater from the right of way in the right of way – reclaiming half of the width of the street for permeable surface. As such we explored street designs that were narrower, not separated (shared), and conflict-free. That revealed itself in a series of cross-sections where the roadway width was reduced, given over to other uses (bikes, landscaping, stormwater management), and/or dematerialized in such a way to not be a roadway at all. Perhaps the ultimate possible with CAVs in a residential setting is the end of streets per se. Paths will do if the CAVs are super safe, smaller, and coordinate.

Why is this a good idea for your city?
The clear boundaries of the Shadyside neighborhood, defined by four surrounding arterial avenues, makes it an ideal district for engaging residents in the creation of the city's first CARE zone. Walnut Street, being closed at each end and thus not a regional through-street, is the commercial spine at the center of its residential walk-shed. The lack of regional through-traffic makes Walnut Street an ideal test case for a radically redesigned streetscape and CAV-mobility hub, a highly shared space allowing pick-ups and drop-offs where public transit is not normally available. For the commercial section of Walnut Street, the concept foresees a greater need for drop-offs and pick-ups.

The residential site allowed us to focus on the interplay between CAVs, site layout, and urban design. We were less concerned with higher order operations and more with creating a place for human habitation uninterrupted and/or defined by a car-based ordering system. Our neighborhood had clearly been designed to offset the negative impacts of motorized traffic (buildings set far back from the street, wider streets than necessary given the amount of traffic, restricting cars to the street). With CAVs much of the reason to disassociate the buildings from the street is eliminated (and more so if noise and emissions are reduced). This allows for a re-thinking of the street, curbs, dedicated lanes, etc.

As for the green infrastructure, if the 10% of the land area in Pittsburgh currently used for roadway can infiltrate storm water onsite, the potential to reduce the number of CSO events would be significant. This residential site has potential to be a great testing ground for a myriad of ways that CAV may impact roadways as it is in a relatively self-contained neighborhood – not a major through-street, but also well connected.

"As someone who gets around by walking or biking, my biggest hope is that autonomous vehicles will lead to less car accidents, and to streets and roads that are friendlier and safer for pedestrians and cyclists."

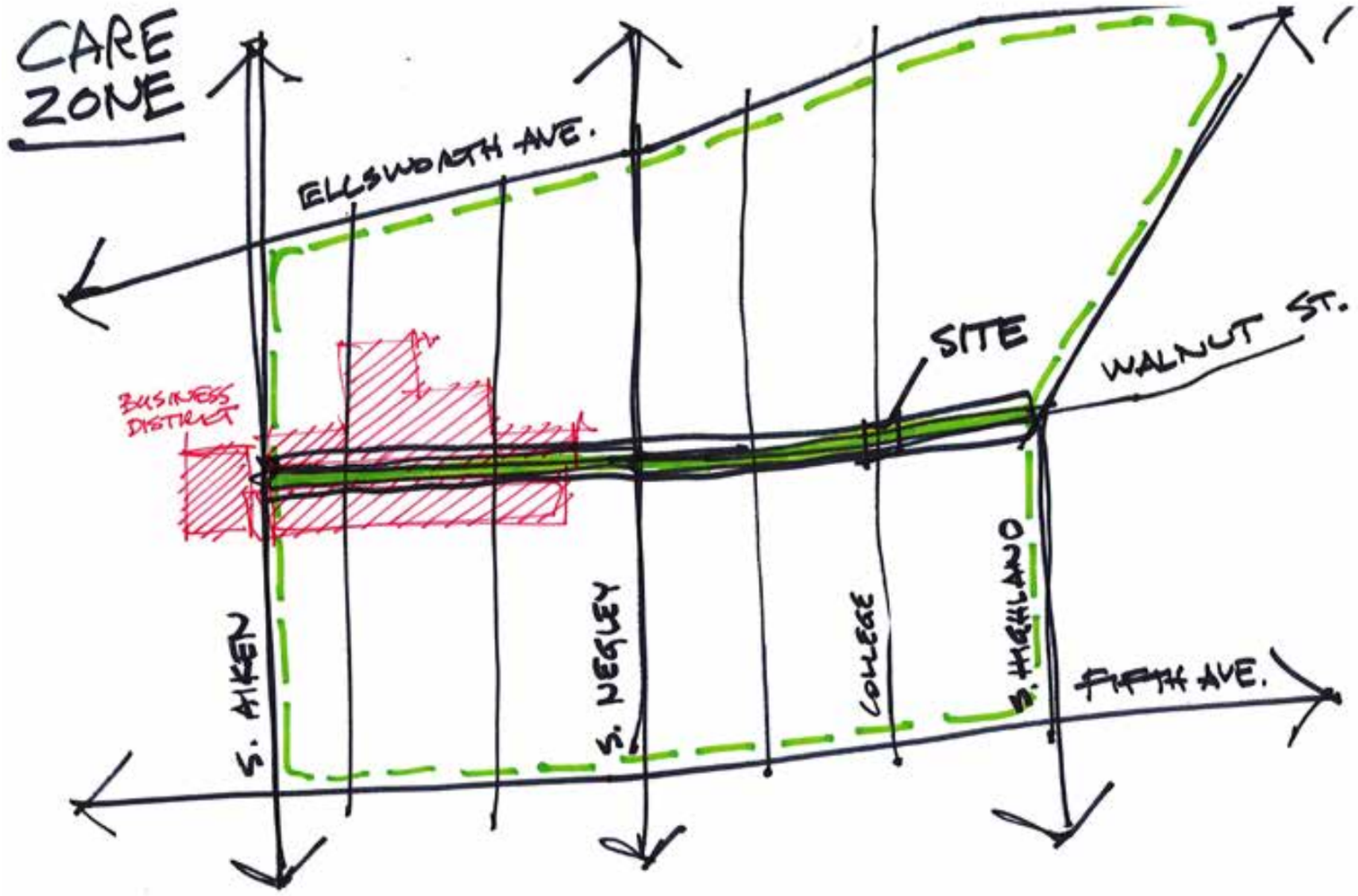
Kristen Osterwood
Technical & Policy Director at Green Building Alliance

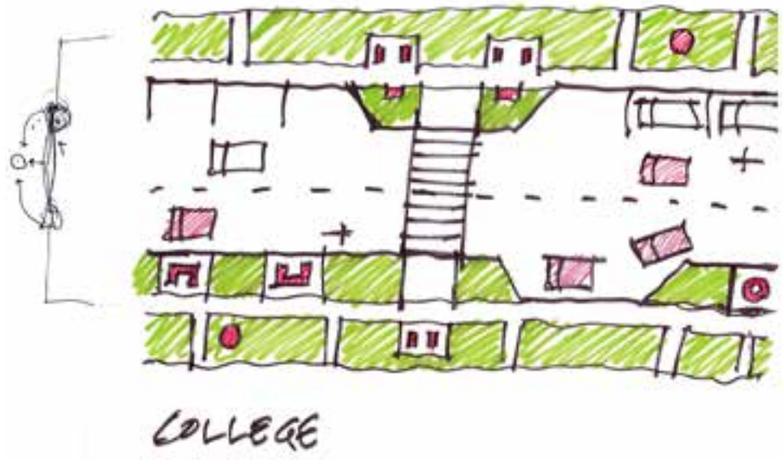
What would need to happen to implement your team's idea?
The CARE zone is an innovative mobility overlay district that requires a combination of city and state level policy changes, as well as funding and implementation of a significant physical transformation of the public realm. Most importantly, approvals would be dependent on strong community support. The city would therefore need to work closely with the community to implement the CARE zone. The planning process would begin with a robust community process to build consensus for the neighborhood's taking a proactive role in planning for the technology changes widely expected to emerge in the next few years. Precedents for such an initiative include community resiliency plans and business improvement districts.

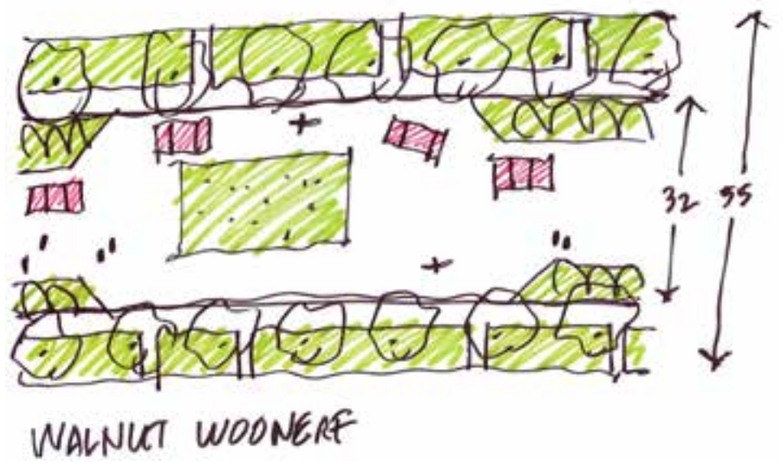
Given the challenge of financing public realm improvements, partnerships with technology companies will provide an opportunity to raise funds for a pilot project and proof of concept. The zone is a controlled environment where multiple CAV designs developed by different companies can be tested and refined, along with the infrastructure required to support CAV use, such as sensor and signal networks. Approval of the CARE zone thus gives the community access to a range of new public and private investment.

The reclaiming of the streets for non-vehicular uses may be organic as there are less cars and people feel safer around cars. Tearing up half the road to allow for infiltration and other green infrastructure could potentially be funded in part by Alcosan, as part of the effort to comply with the Consent Decree.

3.3 WALNUT STREET - TEAM 1







3.4 WALNUT STREET -TEAM 2

Damon Weiss (EthosCollaborative), **James Anderson** (RAND Corporation), **Laura Carey** (Gensler), **Lucinda Beattie** (Pittsburgh Downtown Partnership), **Mark Magalotti** (Center for Sustainable Transportation Infrastructure), **Scott Bricker** (BikePGH), **Stan Caldwell** (Traffic 21 at CMU)

Write-up by **Laura Carey**

What is your team's idea?
Our team explored Walnut Street with the assumption that car ownership in single-family residential neighborhoods would decline in an era of connected and autonomous vehicles. Additionally, there was a great deal of discussion surrounding the policies and individual cooperation necessary for connected and autonomous vehicles to be made mainstream in a lower density neighborhood with an established (and robust) character.

Our team agreed on a mixed-state condition where individually-owned and shared autonomous and conventional vehicles cohabitate. This implies that we envision our site as connected to its context, and progressing at the same rate as the rest of the city in terms of CAV penetration. With these assumptions in mind, we developed a concept.

Remove on-street parking except for an area designated for parking where personal or fleet vehicles (approximately 1 space per every 2 households ~10 per neighborhood) could remain. Vehicles would depart from parking zone to pick up residents at their door. This would free up approximately 12-16' from right-of-way (ROW) for alternative uses. Unfortunately, due to the presence of trucks and buses, driving lane sizes cannot be reduced to account for potential change in personal AV size.

Sidewalks and bike lanes maintain their autonomy but do not require curbs or physical separation (i.e. bollards). Differentiation in modes of travel can simply be indicated by/optimized via surface treatment. For vehicular traffic, a 12' reversible AV lane allows for the movement of traffic. The remaining 16' of the ROW becomes a shared zone whose character varies along the length of the street to provide outdoor amenity space for the residents/ and or neighborhood. Also, by aligning vehicular traffic to one side or the other of the street (and using chicanes) the shared space can be combined into larger areas expanding the potential uses. This shared zone could also be thought of as a newly reclaimed amenity space that functions at both the local and the regional level serving a variety of potential interests (sustainability, community building, energy production, etc.).

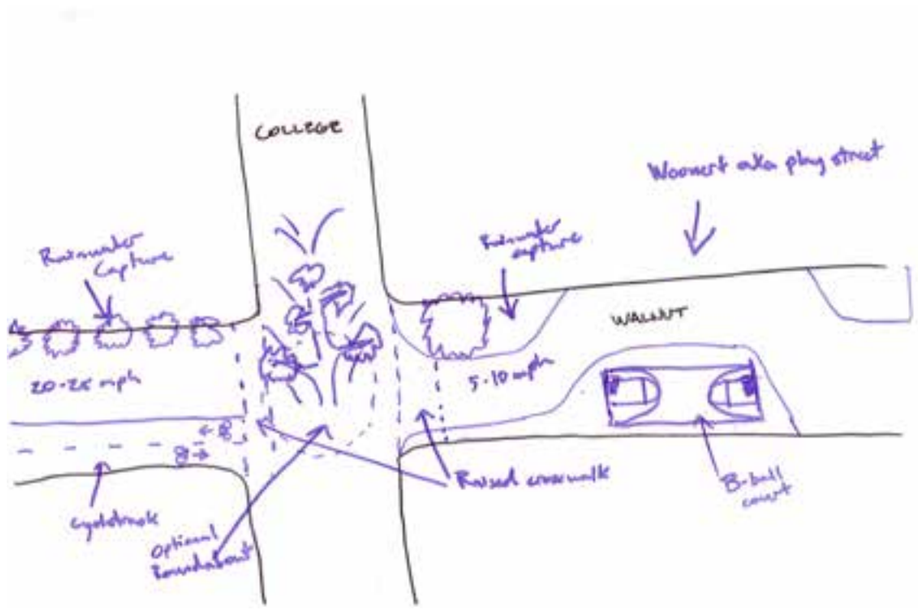
Why is this a good idea for your city?
This approach allows the current ROW to remain intact, while allowing for increased amenity space, or, at a minimum, a reduction in paved surface area, and making a preference for alternative transportation methods. By designating an area within our site for CAVs or personal parking, travel time and distance could be reduced.

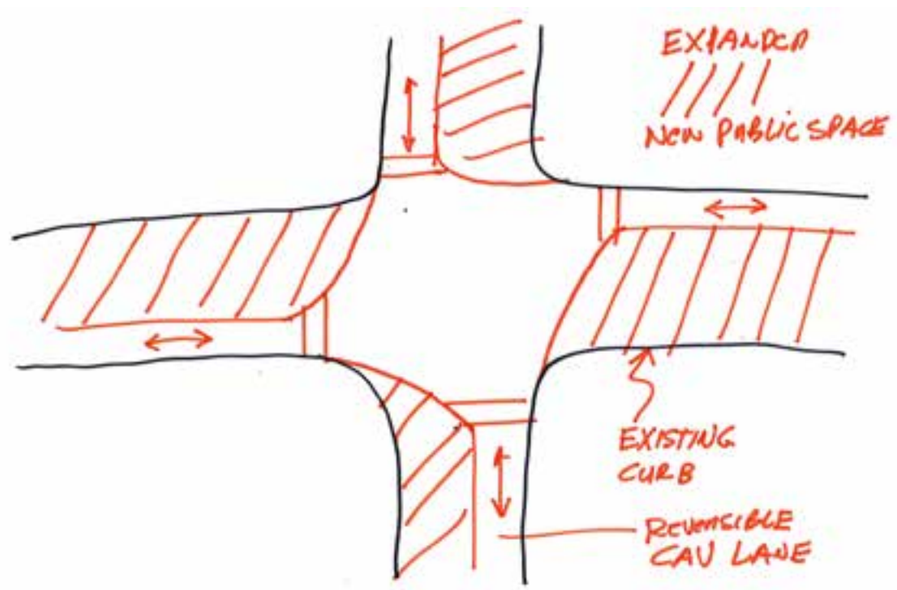
What would need to happen to implement your team's idea?
In order for this to be implemented, on-street parking would need to be restricted. Additionally, to determine the location of the parking sites the ownership model for the CAVs or fleets would need to be determined. Street signage could be modified to indicate the presence of vehicles as well as peak traffic times signalling the availability of road space for pedestrians or bikes.

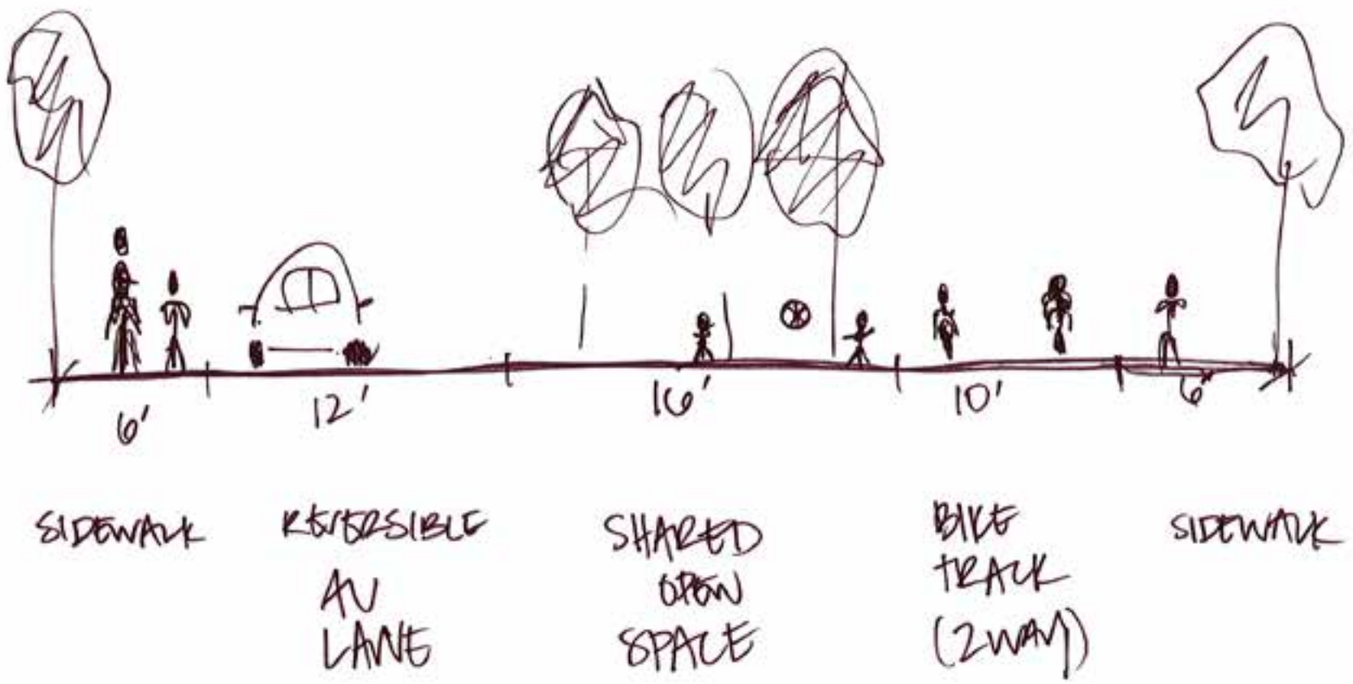
"The Design Sprint was a great opportunity to work with a range of skilled professionals to better understand the way that this set of technologies may shape the built environment and begin to think about the long-term effects."

James Anderson
Director of the Justice Policy Program at Rand Corporation

3.4 WALNUT STREET - TEAM 2







3.5 CARSON STREET - TEAM 1

Chris Sandvig (Pittsburgh Community Reinvestment Group), **Jordan Fischbach** (RAND Corporation), **Kevin Kunak** (Rothschild Doyno Collaborative), **Nick Ross** (HDR)

Write-up by **Kevin Kunak**

What is your team's idea?
Our design idea proposes a transformation of East Carson Street into an urban boulevard, a traditional street type adapted and reimagined for a future where autonomous vehicles allow us to focus on a public realm focused on people. In addition, we propose the redesign of parallel side streets into a network of green streets focused on bike lanes, pedestrian trails, and local neighborhood vehicle traffic.

We envision a future where the City of Pittsburgh is a Level 5 autonomous vehicle environment. East Carson Street is transformed to include a mix of autonomous traffic with dedicated lanes for trucks, transit, and cars. The boulevard includes high volume center lanes dedicated to trucks and transit. On either side of the center lanes, a planted median separates lower volume, lower speed commuter lane for autonomous passenger cars. On-street parking would be replaced with additional sidewalk width, green infrastructure, and drop-off and pick-up areas.

Why is this a good idea for your city?
The study area defined for East Carson Street includes a wide right of way that can accommodate future lane reconfiguration. A boulevard with dedicated traffic lanes can also accept transitions from different autonomous levels.

Center lanes can be dedicated to Level 5 bus rapid transit (BRT) transit and truck traffic while outer lanes accommodate Level 4 commuter car traffic, changing to Level 5 after a certain time. An autonomous BRT lane provides high capacity for limited stop express buses that have the ability to move much more people through this corridor. In this scenario, transit riders have the option of switching to autonomous passenger vehicles to cover the last mile to and/or from BRT express transit. Off street parking lots along this corridor can be repurposed for in-fill development.

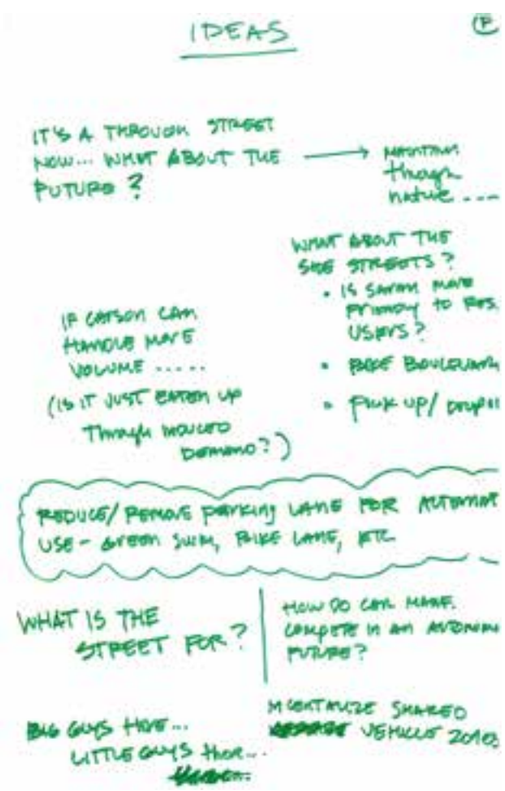
Side streets adjacent to East Carson are transformed into safer neighborhood green streets. Speed limits for local passenger autonomous vehicle traffic can be 20 miles per hour or lower. This lower speed limit supports the addition of dedicated bike and pedestrian trails within the right of way. Neighborhood streets will both be quieter and safer.

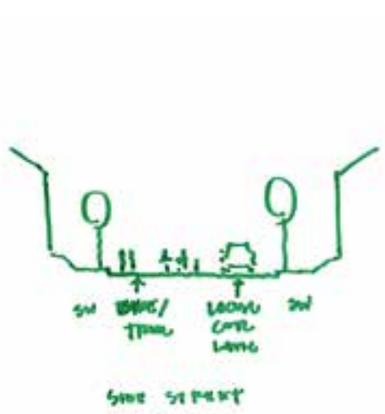
What would need to happen to implement your team's idea?
Streets are complicated environments and we acknowledge the design challenges and complications of a mixed autonomous vehicle street design. Multiple lanes of vehicles traveling at different speeds, pedestrians crossing the street, and vehicles picking up and dropping off passengers present technological coordination problems that will be challenging to implement.

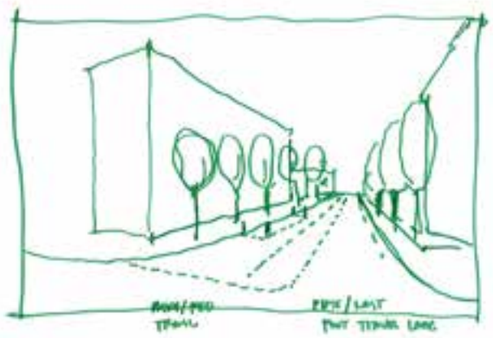
The ability of autonomous vehicles to travel closer together (pooling) and the coordination of vehicle and pedestrian movements at intersections and crosswalks will need to be further studied. We also share concerns that autonomous vehicles may lead to an increase in VMT through cars circling looking for passengers, remote pickups, etc., creating congestion.

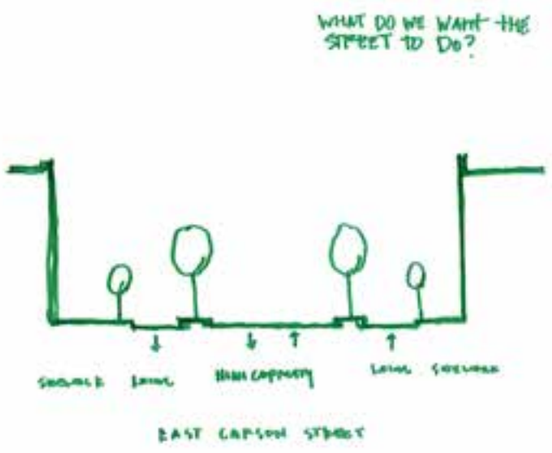
There will be a need for multiple policy changes to realize the benefits and efficiency of Level 5 autonomous vehicles. Restricting non-autonomous driving within this corridor and changes in zoning ordinances that eliminate off-street parking requirements are two examples. The proposed autonomous BRT express lane and transit autonomous vehicles will require a new generation of transit vehicles and coordination with the Port Authority of Allegheny County.

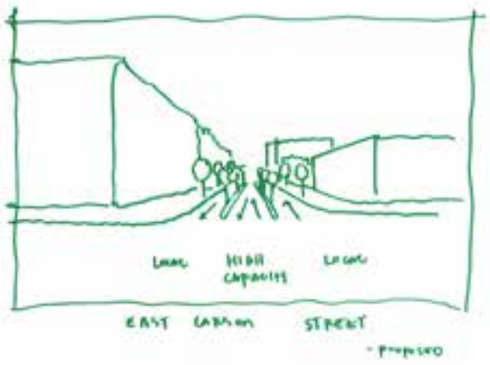
3.5 CARSON STREET - TEAM 1











3.6 CARSON STREET - TEAM 2

Dan Cessna (PennDOT - District 11), **David Sanchez** (University of Pittsburgh - Civil Engineering), **Joe Iacobucci** (Sam Schwartz Engineering), **Stephen Smith** (Robotics Institute, Carnegie Mellon University), **Steven Baumgartner** (BuroHappold)

Write-up by **Joe Iacobucci**

What is your team's idea?
Our idea is based on the premise that people will neither be driving nor owning their cars in the future. CAVs create a rare opportunity to change the transportation paradigm in cities. Maybe even more important than the new mobility options, CAVs will have the opportunity of creating secondary benefits.

Our team acknowledges the opportunity of secondary impacts and came up with a concept that would add much-needed space to the pedestrian realm in Pittsburgh without reducing neighborhood access by converting street parking spaces to more productive uses. Key components of our plan include a reallocation of space that is currently utilized for street parking to pedestrian and bicycle facilities and doubling the amount of space dedicated to the pedestrians and cyclists while allowing to maintain current through lanes of traffic.

All access in the neighborhood will be focused on a new mobility hub. The mobility hub will include access to/from the neighborhood through shared mobility services such as transport network companies (e.g., Uber or Lyft), bikeshare, and the current bus route that serves the neighborhood. This mobility hub would also contain way-finding and signage to ensure an intuitive experience for visitors. This mobility hub would be a repurposed site of a gas station. Our team envisions that gas stations would become obsolete in a world of post-consumer fuel and the transition would be necessitated by the demand of CAVs and growing popularity of transit and bike share systems.

Finally, our plan includes desired sustainable elements, as pervious pavement, along with technology-enhanced signal and lighting systems that would allow traffic flow to be managed throughout the day and allowing changes in the direction of travel.

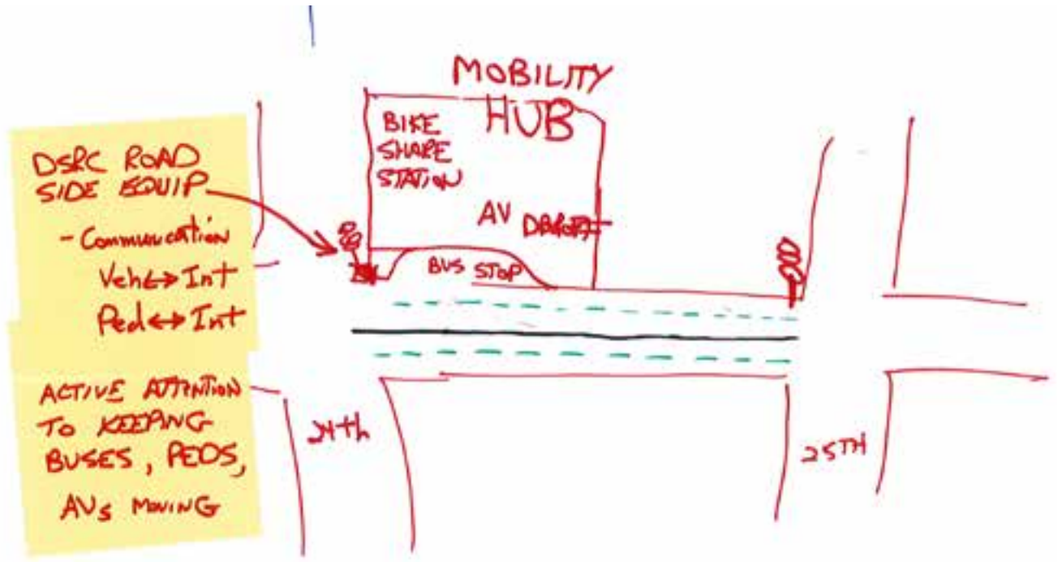
Why is this a good idea for your city?
The idea for the site is imaginative, smart, and practical. It is imaginative from the standpoint that our roadways dedicate too much space to the storage of vehicles and we project that CAV will eliminate the need to own (and store) cars on our streets, freeing up valuable urban space to pedestrians and bicyclists. The idea is smart because it creates new active urban spaces and enhances the pedestrian realm without limiting access to the commercial blocks in the neighborhood. Utilizing an existing gas station as a shared mobility hub makes this plan very practical.

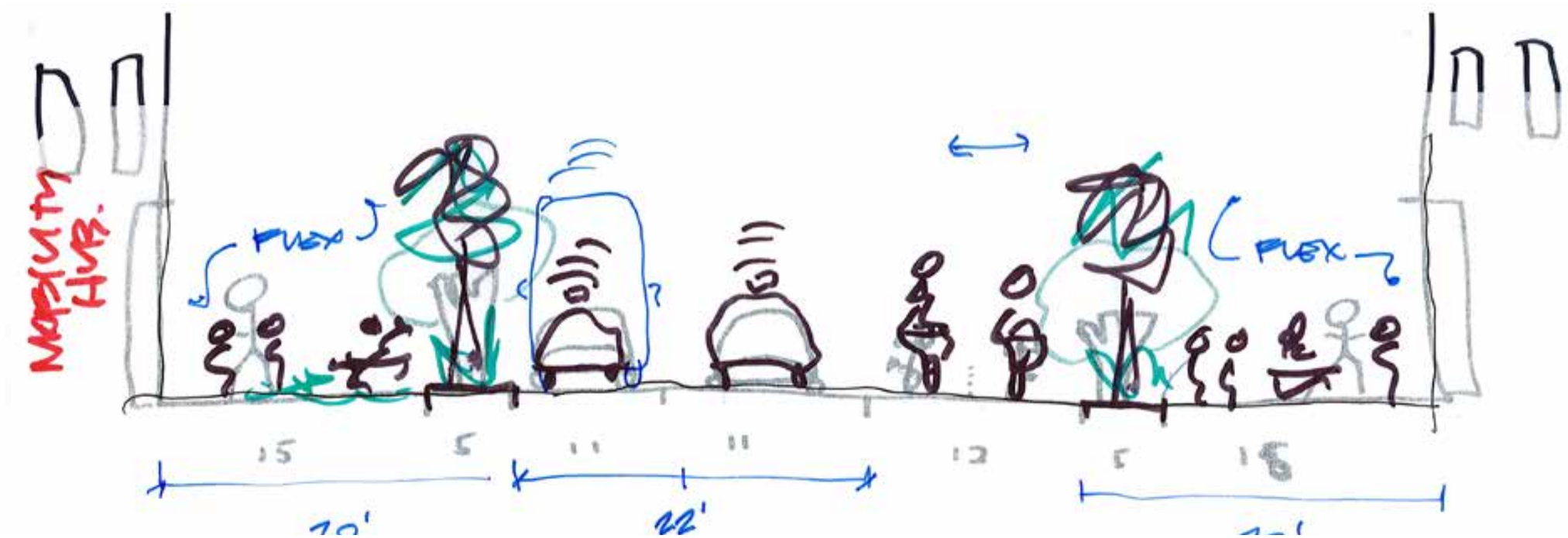
What would need to happen to implement your team's idea?
The idea would need a full transition to CAVs operating in the Mobility as a Service paradigm. This would eliminate the need for vehicle ownership while providing additional transportation options for residents and visitors.

"My biggest hope is that cities can enhance access, optimization, and equity as part of this monumental shift in the transportation field."

Joe Iacobucci
Director of Transit at Sam Schwartz Engineering

3.6 CARSON STREET - TEAM 2





RIYADH : DECEMBER 10 2016

4. RIYADH SPRINT

Riyadh is a rapidly growing city. To accommodate the growing population, the government is currently investing in a world-class public transportation system and building the Riyadh Metro. This contrasts with the other Design Sprint cities of the US and Europe (maybe with the exception of London) where investment in public transport is relatively low. It is thus interesting to explore the question how the introduction of autonomous and connected vehicles will impact the city of Riyadh.

Riyadh's Design Sprint took a slightly different format by having eight teams from the engineering and architecture departments of three different universities – Alfaisal University, Prince Sultan University, and King Fahad University for Petroleum and Minerals – competed against each other in the Design Sprint. In addition, each of the eight teams was joined by two high-school students from the British International School in Riyadh to help imagine what the future of Riyadh could be with the introduction of connected and autonomous vehicles.

The full-day Sprint got kicked-off by a series of speakers, talking about Riyadh's transportation strategy, the technology, and the design implications of CAVs. Dr. Tarek Mokhtar, chairman and assistant professor of Architectural Engineering in Alfaisal University, welcomed the students and introduced the topic by sharing the lessons learnt from the Google prototype. He also got the students thinking creatively by sharing examples of futuristic city concepts.

Mr. Muath Khilfawi, general regional manager at Careem Transportation Company outlined the potential role of CAVs in transportation companies and suggested that owning one's personal car will become increasingly inconvenient. Instead, he pleaded for the need of reliable, affordable and consistent modes of transportation. Similarly, Dr. Jalal Nafakh, head of transport planning at the Arriyadh Development Authority, pointed out that while driverless cars will certainly be a competition for the metro currently under construction, the investment is still worthwhile as Riyadh's streets are at capacity. He however also stated the government's support for autonomous vehicles as it sees a lot of benefits, especially when the fleet is shared.

Eng. Ahmed Jarallah, architect at AlAkaria Architects, spoke of his personal experience living in California and debating the advantages and disadvantages of CAVs. He pointed to some key considerations that need to be taken into account when designing for CAVs, including vertical parking, charging stations, roadside sensors, speed pumps, elimination of off-road parking areas and the reconsideration of drop-off areas. Talking about designing a system for electric CAVs, Damien Ricq, engineer at BuroHappold, argued for the need of more renewable energy to be produced within the built environment and road surfaces. He proposed the gradual development of clean distributed means of electrical generation and smart grid management system to support the energy requirements of autonomous electrical vehicles that are expected to be introduced at large scale in the city of Riyadh by 2030.

The two final speakers focused on Riyadh more specifically. Eng. Ibrahim AlShaye, head of planning and environment in Arriyadh Development Authority, briefly introduced Riyadh's Transport strategy, planning and initiatives undertaken to improve transportation of its citizen more safely and more efficiently. Dr. Anas AlFaris, assistant professor at KACST/MIT, shared an analysis undertaken by his students that showed how users moved within the city and identified points and times of congestion within the city.

Following the introductory presentations, the students were ready to compete for the best ideas around the question of how to reclaim the streets of Riyadh in an era of autonomous and connected vehicles. They looked at four different street sections: Olaya Street, Prince Mamduh Bin Abdulaziz Street, Prince Majed Bin Abdulaziz Road, and Tahliyah Street. In the following section, the ideas of the four winning teams are presented.

We would like to thank the Alfaisal Unviersity and Professor Dr. Tarek Mokhtar for hosting the Riyadh Design Sprint.

RIYADH : SITES

RIYADH: WHY HAVE WE CHOSEN THESE SITES?

OLAYA STREET

Olaya Street is one of the busiest streets in Riyadh during rush hour. However, during the day, it rather has the character of one big car park, due to its massive amount of parking lots alongside as well as in the middle of the road. The introduction of CAVs might give this streetscape a more pleasant appeal.

PRINCE MAJED BIN ABDULAZIZ ROAD

This site is located in the busy neighborhood of Ar Rayyan. It provides opportunities to go grocery shopping and offers a variety of restaurants. Considering the dense uses, there might be the possibility to transform this street scape into a more pedestrian friendly meeting place through the introduction of CAVs.

PRINCE MAMDUH BIN ABDULAZIZ STREET

A smaller version of Prince Majed Road, different shops and restaurants can be found here. Through the introduction of CAVs, the ground floor uses could profit from more open space in front of their doors, instead of directly facing a row of parking lots and a narrow pavement.

PRINCE MOHAMMED BIN ABDULAZIZ STREET (TAHLIA)

Tahliya is one of the main downtown streets in Riyadh. It is a commercial street that offers a large selection of restaurants and cafes which makes it a hub for various cuisines. The street hosts plenty of social events which increase in the number of vehicles on the street and raise congestion level. The best way to regain control over the street is by introducing CAVs.

4.1 PRINCE MAMDOUH BIN ABDUL-AZIZ STREET

Hamza Khilfawi (Alfaisal University), **Khalid AlMunif** (Alfaisal University), **Tariq Alshahrani** (Alfaisal University)

Write-up by **Dina Haddad**

What is your team's idea?
After exploring Prince Mamdouh Bin Abdul-Aziz Street, the team came up with the concept of creating overhead smart routing railway systems dedicated for autonomous vehicles to move people around the city of Riyadh, leaving the ground level free of vehicles. The purpose was to allow CAVs to efficiently move within the city, reducing congestion and bringing the city of Riyadh closer together.

The basis of the team's idea was that streets where residents live should be designed for the use of pedestrians. The aim of their design was to allow pedestrians to claim back the safet use of the road since currently they are considered to be the most vulnerable users. In order to do so, the team came up with the idea of transforming the major highway into pedestrian walkways and cycling lanes. The team pictured the major highways with more trees and landscaping separating different pedestrian zones. This is meant to increase oxygen levels, increase air humidity, reduce urban heat island effect and reduce noise pollution within the district. Altering the major highway into pedestrian walkways will assist in connecting the buildings to the street and therefore increasing the public access to local businesses. The minor streets, within neighbourhoods, were imagined to remain the way they are and to act as drop off hubs for CAVs in order to facilitate the process of reaching an exact destination. The purpose behind the team's design was to enrich the pedestrian's experience without limiting access to the neighbourhoods.

The technological highlight of the design was the usage of hydraulic lifts throughout the railway system as means for moving CAVs horizontally and vertically across the rails. The railways are to be operated by directly connecting to photovoltaic fields and an emergency fossil fuel generating system. The railway in turn will be responsible for charging autonomous vehicles as they move within it. This idea emerged with the hope of eliminating the need of having spacious charging stations for autonomous vehicles and freeing up urban spaces for other uses.

The overhead railway system allows for future flexibility, as it would be easy to vertically add lanes within the same system. There is a dedicated emergency lane within the railway where no vehicle other than emergency vehicles such as ambulances, fire fighters, and police cars is allowed. Because the movement of CAVs will be controlled by the rails, there will be less chance of accidents leading to less congestion alongside efficiency in acceleration and braking that will also help improve fuel efficiency and reduce carbon emissions.

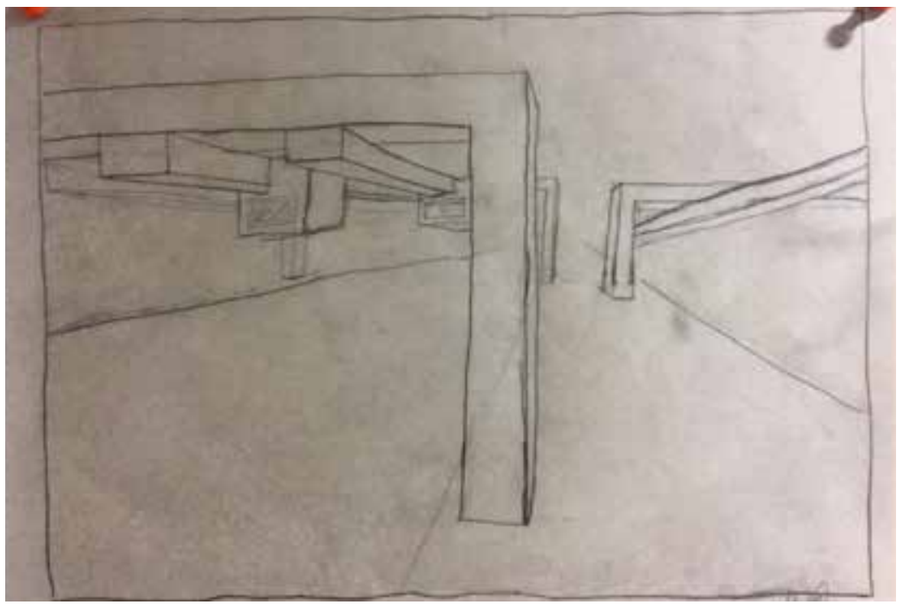
Why is this a good idea for your city?
Although walking is an essential human activity and a vital form of transportation, city planners in the city of Riyadh seem to have disregarded making a pedestrian friendly environment and enhance walkability in the city. Instead, they showed an entire bias to city-mechanized form of transport. More attention was given to multi-lane high-speed roads that made walking unsafe. This lead to heavy reliance on cars and less walkability thus high levels of obesity. The team's idea of transforming highways into pedestrians and moving all vehicles off ground level will solve this problem and help Riyadh citizens to start having a healthy lifestyle where walking will become something essential. The design focuses on obtaining a sense of security and adding pleasantness to the streetscape.

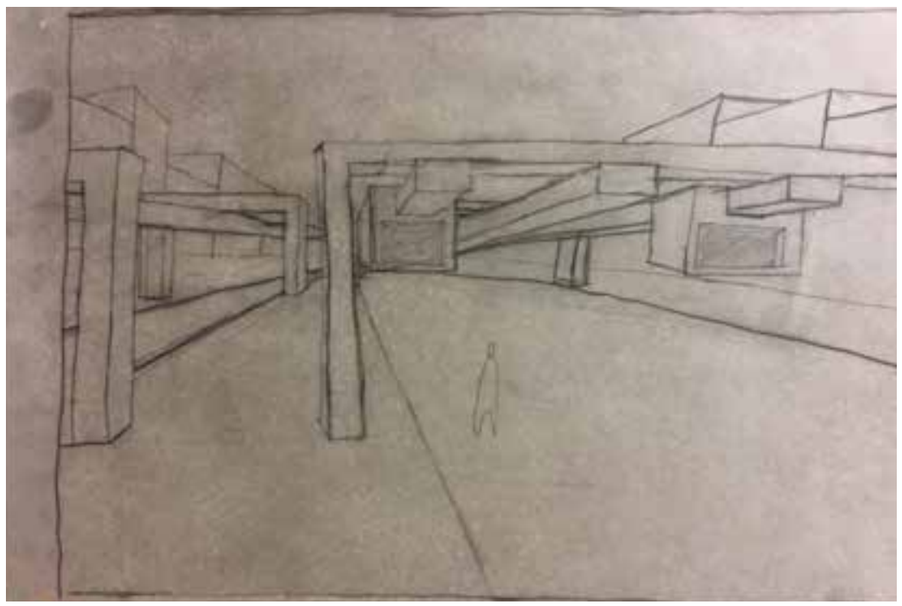
The implementation of the team's idea will as well affect Riyadh's economy in terms of greater government revenues through commissions on autonomous vehicle fares as well as greater foreign oil revenues due to decreased domestic use. Transportation fees will greatly decrease with the illumination of drivers and will be an extra income to the government.

Since women in Riyadh cannot legally drive and have a driving license, autonomous vehicles will allow them to move easily within the city while controlling the vehicle without breaking traffic rules and social prohibitions.

What would need to happen to implement your team's idea?
In order for the team's idea to be implemented, a complete evolution to CAVs should be adapted where car ownership does not exist. A new infrastructure "smart routing overhead railway system" is to be constructed.

4.1 PRINCE MAMDOUH BIN ABDUL-AZIZ STREET





4.2 OLAYA STREET - TEAM 1

Omer A.Aziz Eltahir (King Fahad University for Petroleum and Minerlas),
Yousef AlSari (King Fahad University for Petroleum and Minerlas),
Ahmed Ayyad (King Fahad University for Petroleum and Minerlas),
Mahmoud Hassan Eltourky (King Fahad University for Petroleum and Minerlas)

Write-up by **Khaled Alkhalil**

What is your team's idea?
Olaya street could be considered the business centre in Riyadh. Alongside the presence of international companies and major retail brands, the street hosts a number of city landmarks, luxurious hotels and important governmental entities. The team recognized the importance of the street and wanted to come up with a design that can help supporting and improving the lively nature of Olaya. The new concept aims to create an integrated transportation system by having three different levels for the street. Each level will have a different mean of transportation and special characteristics.

An Underground Level:
One of Riyadh's metro lines is currently being constructed under Olaya road. The train can be used for the long-distance travel along the street. After arriving at a station, the passenger can move to a different level through stairs or ramps and navigate to the exact destination.

The Ground Level:
The ground level is actually the existing street level which will be used by autonomous and regular vehicles for medium traveling distances. The street will consist of 3 lanes in each direction, two for cars and one for buses and emergencies. A drop off zone should be provided every 200m and a bus station every 750m. The team wants to incorporate piezoelectric technology with the surface of the street. Using piezoelectricity, electricity can be generated from the stress applied by vehicles movement on the surface where the energy from the pressure is converted to electrical charges. The generated electricity can be used to operate traffic lights or low voltage devices on the street.

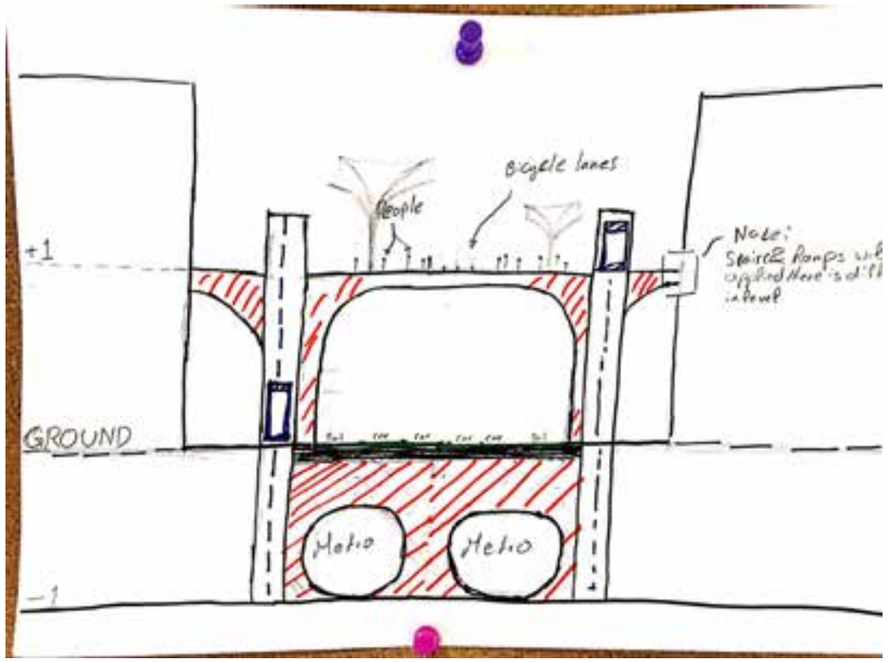
The Elevated Level:
The elevated level will be utilized by pedestrians and cyclists. The team suggests the use of steel as the main construction material for the structure of the elevated level. In addition for being recyclable, steel structures can be designed in a standardized way where prefabricated pieces can be used along the whole street and allow easy assembling and disassembling of the structure. Shading umbrellas will provide comfort and protection from Riyadh's blazing sun. These umbrellas can be equipped with solar cells to generate electricity that can be used to operate billboards or some pedestrian services along the walkways. Vegetation and landscape will occupy some of the large area on the elevated level to provide cooling and better scenery for the pedestrians.

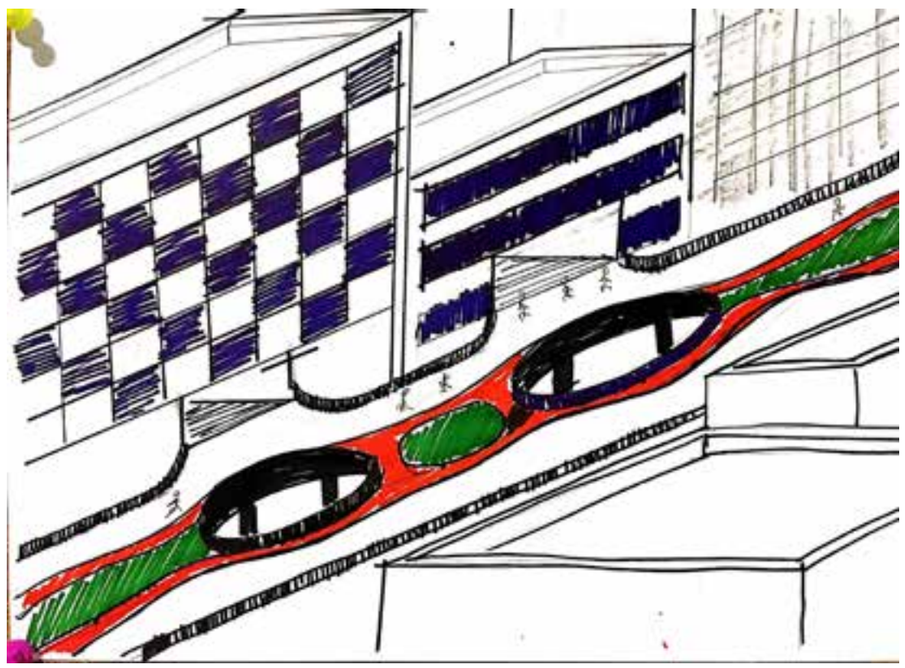
Why is this a good idea for your city?
Creating three separate levels for different means of transport will allow a full utilization of the street. The reduction of the everlasting traffic congestion of Oalya will help in improving the connectivity between businesses and enhancing the commercial activity on the street. The wide walkways of the elevated level will further promote pedestrian movement and flow of people between the buildings on both sides of the street.

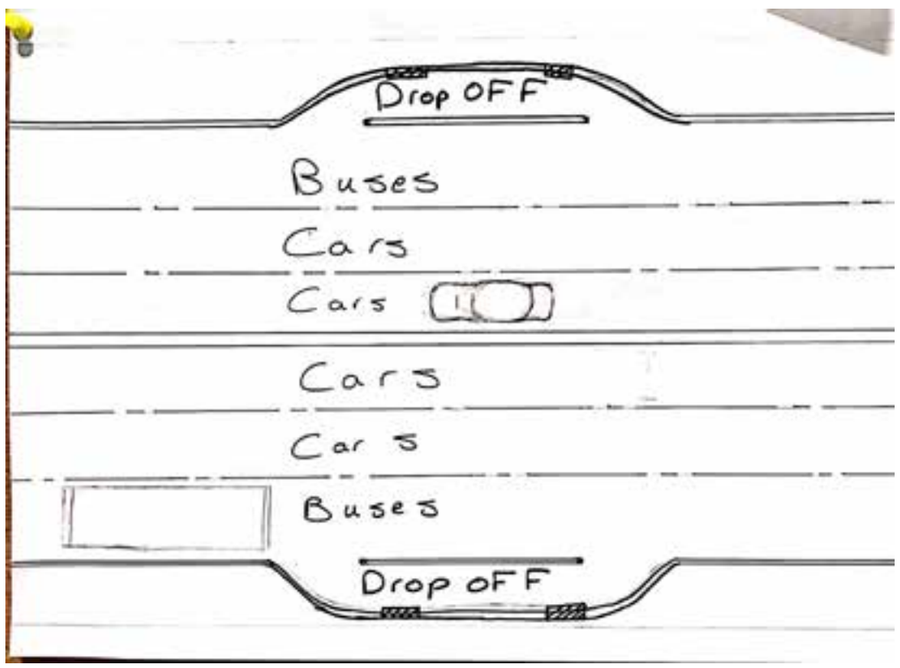
Sustainable electricity supply from solar cells and piezoelectricity in addition to the use of CAVs will decrease CO2 emission and improve air quality on the street.

What would need to happen to implement your team's idea?
CAVs will redefine the shape of the urban fabric of the city in the future. Changing the scape of the streets should be on sequential stages. where people can learn and adapt to the new system. Policies should

4.2 OLAYA STREET - TEAM 1







4.3 PRINCE MOHAMMED BIN ABDULAZIZ STREET (AL-TAHLIA)

Al-Baraa Al-Saour (Prince Sultan University), **Khaled Abalkhail** (Prince Sultan University), **Sari Ghassan** (Prince Sultan University), **Talha Shahd Ali** (Prince Sultan University)

Write-up by **Khalid Alkhalil**

What is your team's idea?
Tahliah is one of the most active and dynamic roads in Riyadh. The road is relatively wide and consists of 4 lanes in each direction. The idea is built around utilizing the road's current assets and characteristics to establish a simple yet practical system to run both regular and autonomous vehicles.

Street Design:
The new concept requires having two main lanes in both directions and a drop off lane on each side, in addition to a "dynamic" lane in the middle. The lanes will be utilized for different purposes as follows (from the outside to the inside):

- Drop off lanes: CAVs will use this zone to pick up or drop off passengers. Upon the drop off, CAVs will head to the nearest parking building where they can be charged.

- Two main moving lanes: The inner lane (Lane 1) is to be used primarily by autonomous vehicles, while the other lane (Lane 2) is for regular or partially autonomous vehicles.

- Middle dynamic lane: This lane is equipped with movable barriers that can open and close on both sides. The barriers will open from one side to provide an extra lane for the congested direction of the road since traffic density in each direction differs depending on the time of the day. However, the lane is primarily intended to provide a passable way for emergency vehicles such as: ambulances, firefighting vehicles, and the police. In case of an emergency, central control system will inform all the CAVs in the middle lane to move and make a way for the emergency vehicle.

The remaining area of the road will be reclaimed by open spaces and pedestrian walkways.

Parking Buildings:
Whenever an autonomous vehicle drops off its passengers, it will either go to do another scheduled ride or head to the nearest parking building. The building will be equipped with solar panels to provide charging. Besides charging the electrical vehicles, power will be stored in battery cells to provide charging in the evening. Charging in the evening would be more expensive than charging during daytime.

Emergency Radar System:
In addition to having artificial intelligence, connected and autonomous vehicles use the internet to transmit data and information to coordinate movement with other vehicles and to keep a smooth fluid flow on the road. However, additional infrastructure is needed to maintain the system in case the internet is down. A radar system covering the street will allow the vehicles to establish temporary connection between each other to communicate information and prevent accidents.

On-the-go Energy:
A very important aspect of having an autonomous vehicle is the ability to keep it going on the road without stopping. Constant utilization of autonomous vehicles at all times can be vital for the future of car sharing services. The need to charge the vehicles could be the main reason that could take the vehicles off the roads every now and then. To overcome this issue, the team came up with an idea to provide charging for the vehicles while they are on the street. The idea is to have reflective panels along the barriers of the road. The reflectors will direct sun rays towards solar cells above the vehicles which will convert the solar energy into electricity. Sensors will adjust the reflectors to the optimum direction at all times and provide the vehicles with a constant source of energy supply.

Harnessing Technology:
Our team also imagines CAVs to have the ability to monitor heart rate and other health indicator of their passengers. This will allow a vehicle to detect emergencies such as heart attacks, to take the passenger to the closest medical centre, and report the incident.

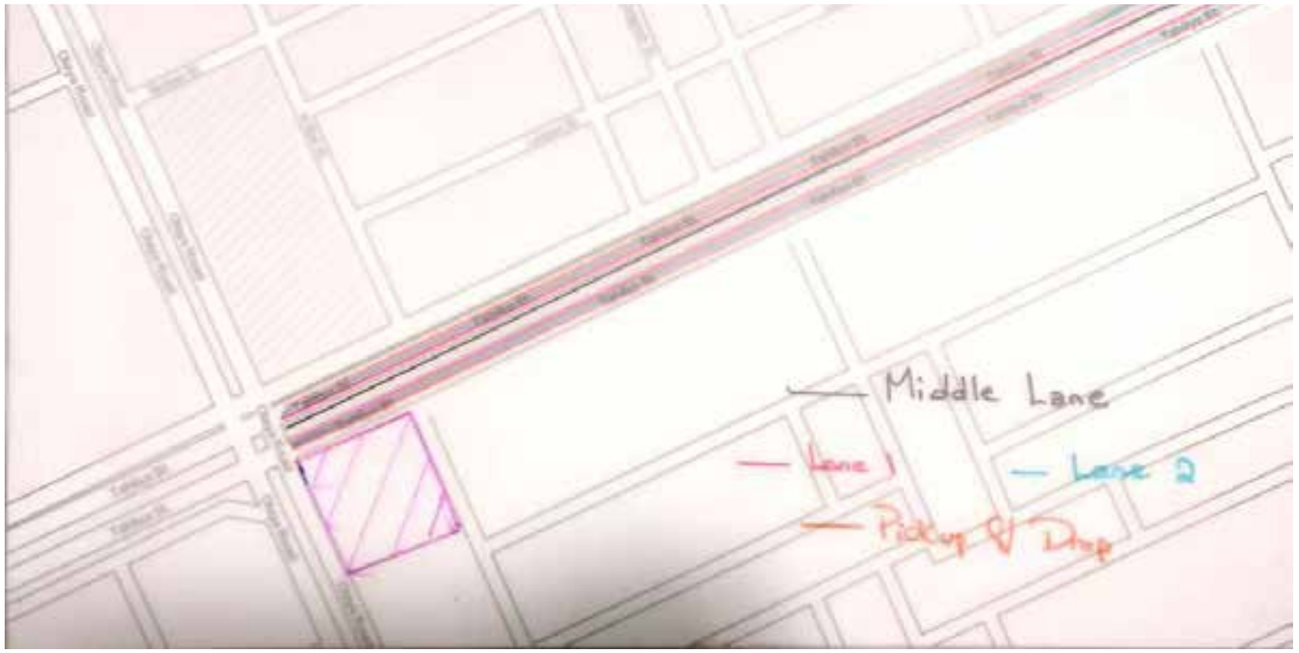
Why is this a good idea for your city?
Environmental impacts:
There will be a massive reduction in carbon dioxide levels due to the use of electric vehicles and solar energy. In addition, the reduction of the roads width will allow for creating open spaces that can be used for landscaping and pedestrian walkways.

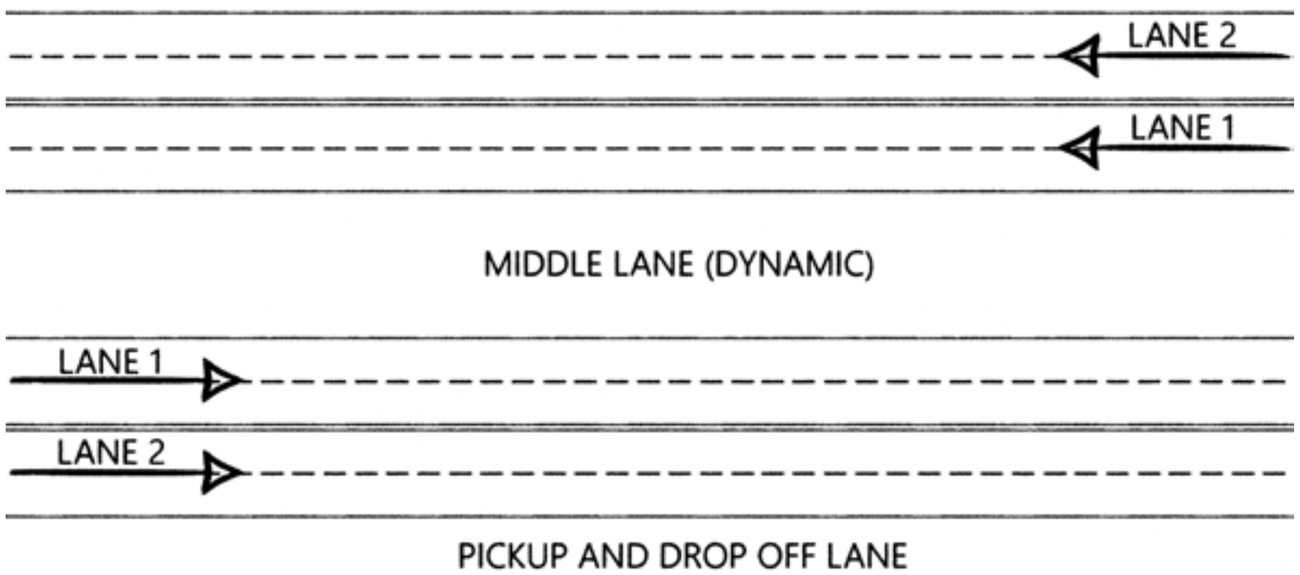
Social impact:
Tahlia is a vital hub for shopping and business. Adding extra space to walk will definitely support the vivid flow of pedestrian in the street. The middle lane will provide a clear path for emergency services to reach their destination and provide a quicker response time.

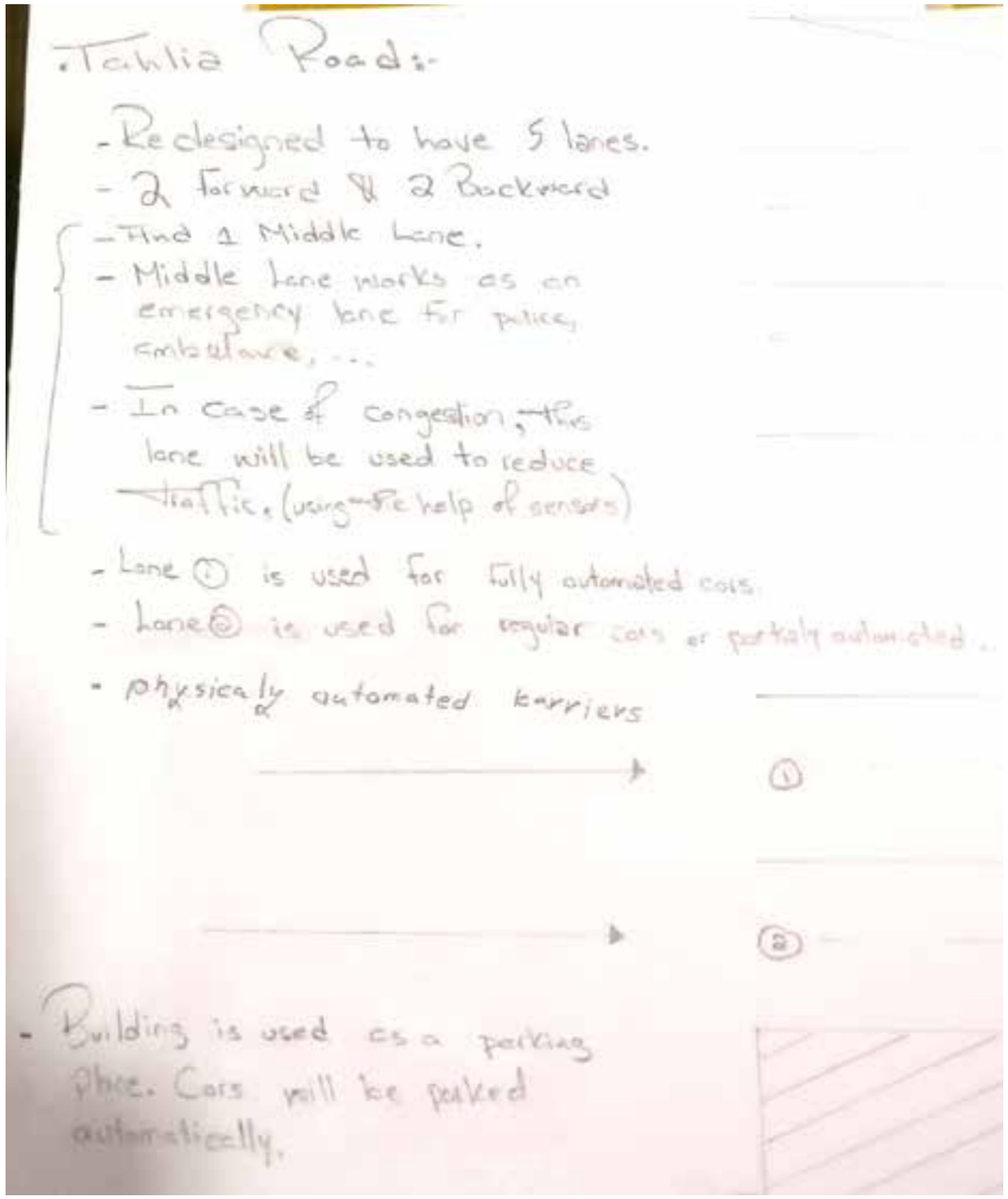
Economic impact:
It comes with no surprise that the autonomous vehicles will take on some jobs related to driving. However, it will also introduce a number of new jobs in other fields such as: control systems and solar energy. The team believes that after the full integration of autonomous vehicles, insurance on automobile should be dropped and car manufacturers are expected to provide warranty programs instead.

What would need to happen to implement your team's idea?
The idea focuses on introducing a simple and implementable design that requires small adjustments of the current existing roads and avoid the cost of adding extra infrastructure. The introduction of autonomous vehicles can happen gradually as the design allows the use of regular vehicles and CAVs at the same time. The first step is to adapt the lane structure and apply new regulation to ensure the right implementation of the system. Additional items and technologies such as the movable barriers and solar reflectors can be added in the future as more autonomous vehicles are being used on the street. The idea can be successively applied on other streets in Riyadh and help in the development of a fully integrated system for CAVs in the city.

4.3 PRINCE MOHAMMED BIN ABDULAZIZ STREET (AL-TAHLIA)







4.4 OLAYA STREET - TEAM 2

Ahmed Samsam (Alfaisal University), **Nawaf Alsayed** (Alfaisal University), **Noureldine Bakhit** (Alfaisal University)

Write-up by **Dina Haddad**

What is your team's idea?
The team's concept evolved from the idea of giving inhabitants a place for a safe and healthy urban street life infrastructure. The team proposes the concept of vertically separating the different means of transportation within the city of Riyadh.

The team's suggestion is the creation of an elevated city walk providing the ultimate pedestrian lifestyle experience with a mix of pedestrian walkways, cycling lanes, and landscaping, corralling pedestrians on a segregated level to make sure they do not get in the way of autonomous cars. The city walk was imagined to have vast voids in order for sunlight to reach the ground level. Diagonal crossways go through the voids acting like pathways that facilitate street crossing for pedestrians. Every 400 meters, a ramp is located for pedestrians to move easily from one level to another. Ideally, each ramp acts like a drop off zone for autonomous vehicles.

The ground level was designed for the use of autonomous vehicles undisturbed by pedestrians. The reason for doing so was to overcome the limitations of congested and traffic compromised street networks alongside reducing vehicle-pedestrian conflicts. One of their crucial elements was the elimination of traffic lights from city intersections to provide continuous flow of autonomous vehicles.

The underground level was dedicated for the upcoming rapid transit system that is meant to connect the entire city of Riyadh. The three different street levels were arranged in a way that the lower you go the faster the transportation system is.

Why is this a good idea for your city?
In the city of Riyadh, pedestrians face a variety of challenges when they walk along and across streets with motor vehicles. Elevating pedestrians to another level will allow them to walk and practice other activities such as cycling and jogging safely.

Congestion chokes almost all the main roads in the city of Riyadh. The team's proposal of removing pedestrians from the ground level will allow street traffic to move freely thus reducing wait times and increasing travel speed and capacity of highways.

What would need to happen to implement your team's idea?
For the idea to be implemented, Riyadh citizens should be prepared to accept the idea of sharing CAVs and be encouraged to use active transport via cycling, walking and public transport while discouraged to use private cars. Riyadh would have to implement a new traffic management system that does not rely on traffic lights. Additional land space should be assigned for solar collectors outside the main urban city.

4.4 OLAYA STREET

DUBAI : DECEMBER 13 2016

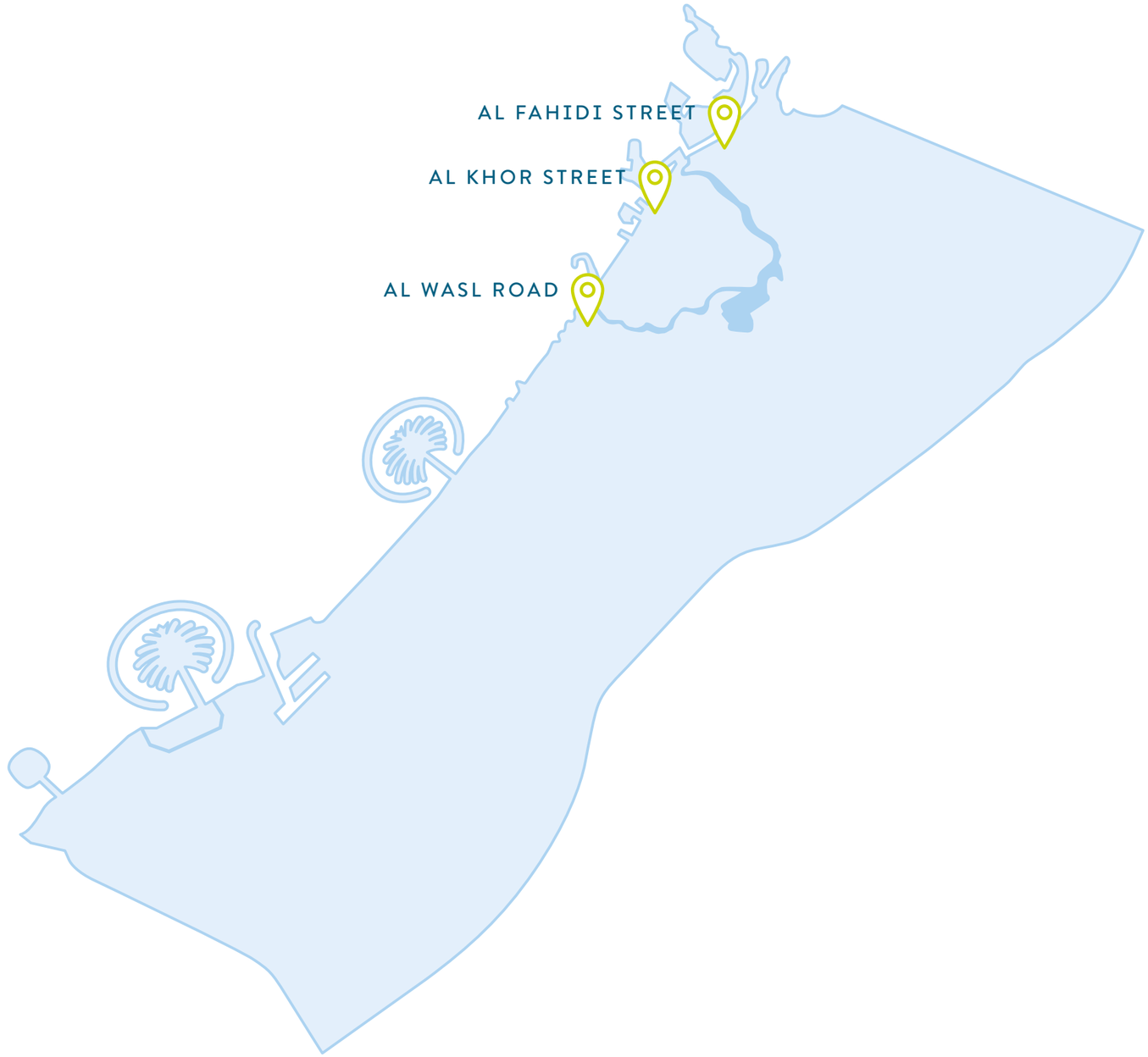
5. DUBAI SPRINT

In April 2016, Shaikh Mohammad Bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, announced on Twitter the launch of a new strategy that sees a 25% penetration rate of connected and autonomous vehicles on the roads of Dubai by 2030. This is part of Dubai's aspiration to become world's smartest city and achieve a more sustainable economy. It was therefore a given that hosting a Dubai Design Sprint will be of great interest to our participants.

The Design Sprint took place in our Dubai BuroHappold Engineering office. After a short welcome from Andrea Scotti, country director of the Dubai Office, Robert Okpala, Director at BuroHappold, introduced the participants to the Design Sprint idea. Following Robert, Jon Foley, BuroHappold's Technical Director for Transport & Mobility, reminded participants that while it is absolutely clear that autonomous vehicles will start taking over our roads soon, there is no certainty on how people will behave and adapt. He further emphasized that the real benefits of autonomous vehicles, such as less congestions on our roads, will only become possible with a shared ownership model. He reminded participants of the opportunities to reduce on-street signage and traffic signal, reduce parking space, and remove physical segregation between pedestrians and vehicles. He also encouraged participants to think creatively, interdisciplinary, and freely. Finally, Rayya Jawhar, Sustainability Engineer at BuroHappold, presented the above mentioned transport strategy launched by the Roads and Transport Authority (RTA) and the key drivers behind the introduction of autonomous and connected vehicles in Dubai: The city does not only want to reduce its current level of congestions on primary and secondary roads, it also wants to become one of the most friendly city for the disabled by 2020. The city also sees the introduction of autonomous and connected vehicles as an opportunity to complement the public transport system as the metro lines are not sufficiently connecting all neighbourhoods in Dubai. Hence, the introduction of autonomous and connected vehicles could provide an opportunity to increase accessibility to transportation in those neighbourhoods currently underserved.

After these introductory remarks, the interdisciplinary teams consisting of university students, urban planners, architects, engineers, transport consultants, and government representatives developed a range of ideas for reclaiming the streets of Dubai in an era of autonomous and connected vehicles. The sites the teams looked at were Al Fahidi street, Al Wasl road, and 16th street. The following section describes a few of the ideas discussed at the Sprint.

DUBAI : SITES



DUBAI : WHY HAVE WE CHOSEN THESE SITES?

AL FAHIDI STREET

Al Fahidi Street is one of Bur Dubai's high street, bisecting the area from east to west and lined with a mix of shops and cafes. The street leads to Al Fahidi heritage neighbourhood, an area that attracts a large number of tourist. Traffic is usually caused by taxi stopping to drop tourists and people stopping on the road to shop.

AL WASL ROAD

Al Wasl is one of the key secondary street in Dubai leading to residential and commercial developments. The amount of signal lights on the street makes it an attractive site for the introduction of CAVs.

AL KHOR

Al Khor Street is one of the busiest street in Dubai during rush hours. The street is surrounded by a large number of shops and lead to the Gold souk. The Gold Souk is one of the main touristic destination in Dubai. The area suffers from a parking problem and is poorly connected to the metro lines. Buses on the other hand aggravate the traffic issue.

5.1 AL FAHIDI STREET

Rawad Choubassi (Systematica), **Chris Boyle** (Masdar), **Aishwarya Chengappa** (Heriot Watt University), **Tim Magill** (5plusdesign).

Write-up by **Rawad Choubassi**

What is your team's idea?
Our team looked at Al Fahidi Street, a street that leads to the Fahidi Heritage Village, one of the key touristic and cultural areas in Dubai.

The ideas our team developed were focused on understanding the impacts of CAVs on: 1) urban and street design; 2) other transit modes; and 3) required policies. First, a significant re-utilization of typical Right-of-Way was achieved where lanes were reduced in width to give more space to pedestrians. Similarly, on-street parking rows were reduced gradually to be replaced by CAV stations in the mid-term and to be totally omitted in the long term. Second, major impacts were foreseen on traditional public transport facilities as CAVs will eventually be a better and more convenient option, especially for cities where walking could be tedious during hot or cold seasons. The impacts most probably will be negative and a number of policies will need to be put in place in order to regulate the use of said modes. Third, related to the previous point, we came up with two potential policies to mitigate the potential negative impacts of CAVs: Defining a cap for travel distance by CAVs, which would allow to resolve the 2-4km connection (midway between the last mile and long-haul transit modes concept) and limiting ownership or encouraging shared CAV models.
The team focused on integrating CAVs within the current transport mix rather than suggesting it as a replacement to what is already existent on site ie: private cars, bicycle, buses etc. The idea is to use CAVs to improve effectiveness and support the current transport system in the area.

Why is this a good idea for your city?
The system has great potential, especially in a dense touristic area home to a heavy disorganised flow of people, cars and buses.

Main benefits are:

- In the long term, reduced fatalities due to high capacity of learning and sharing "knowledge" among connected vehicles;
- Lower car ownership;
- Better connectivity;
- Reduced inefficient use of traditional public transport systems in mid-to-low density urban developments (mainly the peripheries);
- More space for pedestrians;
- Controlled vehicle speeds.

The design will revive the area by creating safe, clean and easily accessible environments, but will also present an opportunity to rethink the public transport strategy and create harmony between the different means of transport public, private and walking.

What would need to happen to implement your team's idea?
The following four steps would need to happen:

01. Create regulations and policies
02. Reach a given number of CAVs on the network
03. Design streets according to new standards
04. Resolve insurance issues (whom to blame in case of accidents!)
05. Behaviour and habit change

5.2 AL KHOR STREET

Ahmad Bukhash (Dubai Creative Clusters), **Ahmad Gaurish Wagle** (Masdar), **Ashish Agrawal** (Heriot Watt University), **Abubakar Bunu Lawan** (Heriot Watt University), **Jon Foley** (BuroHappold), **Husam Raouf** (MontHill).

Write-up by **Ahmad Bukhash**

What is your team's idea?
Our team proposes the introduction of a transit hub/activity hub within a walkable catchment allowing social interaction, active healthy living and sustainable transport mode. This would allow for more personalized transport. The reclaimed space will introduce pop-up retail spaces creating job opportunities, include community garden to grow food, as well as introducing liveable spaces with additional shading. A fast CAV corridor will be maintained, meandering within the ROW, while a slow shared CAV/ pedestrian zone closer to the buildings will allow for pedestrian friendly streets. A fast CAV route will be maintained from/ to PT hubs/ stations. Car parks will be allowed within 10 minutes from the vicinity for convenience. The idea was to give the streets back to the people and to design a system in response to people's need.

Why is this a good idea for your city?
Creating opportunities, connecting people and promoting resilient community principles. The idea means there is a customized transport and lifestyle solution for each resident / commuter without compromising the wider environmental sustainability targets.

What would need to happen to implement your team's idea?
CAVs introduced on dedicated routes from major PT hubs. Then introducing a policy to manage street reclamation and operational strategies of shared CAVs and the local Transit/ Activity Hubs.

5.3 AL WASL ROAD

Abeer Manneh (Heriot Watt University), **Jamie Low** (BuroHappold), **Sneha Ramaprasad** (Heriot Watt University), **Zohaib Shaikh** (Heriot Watt University), **Hrvoje Cindric** (ARUP).

Write-up by **Abeer Manneh**

What is your team's idea?
Our team was assigned the extremely busy and touristic destination of the Gold Souk. Our idea was to revitalize the urban area through the introduction of automated vehicles. Accordingly, we enhanced the streetscape by reducing road widths and parking spaces to accommodate for more greenery and open up new real estate opportunities as more prime property becomes available. The location of the site is considered to be a prime location, due to the close proximity to the creek and to some cultural and heritage sites.The idea was to use CAVs to solve the pollution and traffic issues in the area and raise the value of a land that was once considered prime.

Why is this a good idea for your city?
It highlights how older parts of the city will become more accessible and attractive to investors and therefore lead to a more sustainable growth in the city. It will revive the heritage aspects.

What would need to happen to implement your team's idea?
Government regulation is paramount. We also suggest to pilot the system before it is implemented at a large scale.

BERLIN : JANUARY 18 2017

6. BERLIN DESIGN SPRINT

Germany is at the forefront of the transition towards clean energy. This includes the transition from vehicles with internal combustion engines to fully electric vehicles. Thus, as the future of mobility will not only be autonomous and connected, but also green, we were keen to host one of our Sprints in Berlin. The polycentric urban form of the city, the excellent public transport system and the low rates of car ownership, make Berlin an excellent case for considering CAVs as a wider part of the urban mobility and energy landscape.

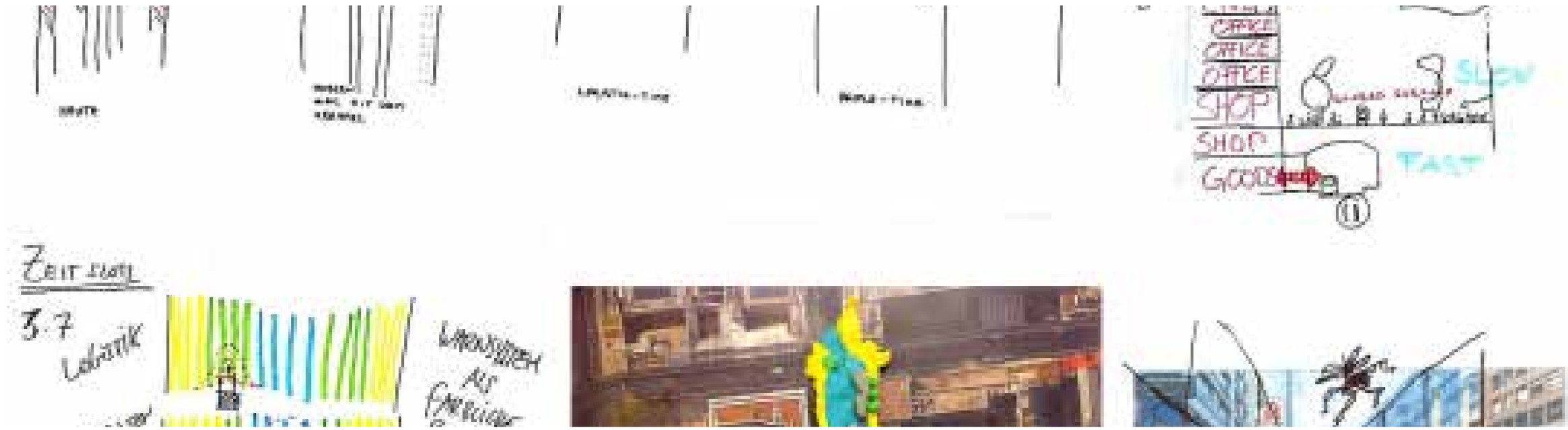
Fittingly, we hosted the Berlin Design Sprint at the EUREF Campus. The campus is Berlin's urban laboratory for the energy transition ("Energiewende") and innovative mobility schemes such as electric car sharing. The EUREF campus brings together actors from different industries, research and NGOs in order to pilot and showcase innovative energy and mobility solutions and allow the public to experience these innovations. One of its tenants is the Innovation Centre for Mobility and Societal Change (InnoZ) with whom BuroHappold collaborated on the BeMobility project. The fact that InnoZ is currently testing the autonomous shuttle bus "Olli" on the EUREF Campus and offered our Sprint participants a ride, made it the perfect location for exploring our Sprint question. Participants in Berlin represented Berlin's government, the public transport authority, the car and technology industry, academia, advocacy groups, architects, urban designers, and planners. The Berlin Sprint was introduced by Burkhard Horn, Head of Traffic at Berlin's Senate Department for the Environment, Transport and Climate Protection, who provided an overview of Berlin's transportation strategy and Professor Jochen Rabe, from BuroHappold's Cities team and the Einstein Centre Digital Future (ECDF) in Berlin, who provocatively demanded the sprinters to keep the human point of view in mind.

After having listened to these input speakers, the sprinters eagerly started exploring the question of how to reclaim Berlin's streets in an era of autonomous and connected vehicles. The three sites explored in Berlin were: The Schloßstraße in Steglitz, a main thoroughfare with retail malls on either side of the street; the Friedrichstraße in Mitte, a major road that includes a tram line and is located in one of Berlin's business districts; and the Hufelandstraße, a residential neighbourhood characterised by on-street parking and cobblestones.

The ideas developed for these sites ranged from the introduction of a road pricing mechanism that takes into account the socio-economic status of drivers, to a system where street lanes digitally open and close according to user demand. The discussion at the end focused, not only on the feasibility of the proposed interventions, but also on the question of how realistic and how desirable an era of autonomous and connected vehicles is. The results made it emphatically clear that Jochen's appeal for a humanistic approach was needed. This was also reflected by BuroHappold CEO, Roger Nickells, who concluded the workshop by stressing the fact that the potential of autonomous and connected vehicles to improve the quality of a city is only achievable if all stakeholders involved collaborate; the city administration, the designers, and the technology providers will need to work together with the users - the inhabitants of our cities - giving them a participating role in the planning process.

"We love challenges like these as engineers and we love challenges like these as BuroHappold. I'm thankful to all participants for sharing their thinking and ideas."

Roger Nickells
CEO, BuroHappold



BERLIN : SITES

BERLIN : WHY HAVE WE CHOSEN THESE SITES?

SCHLOSSSTRASSE

The Schloßstraße is the major shopping street of the district “Steglitz-Zehlendorf” and Berlin’s biggest retail location. It is highly frequented and well connected with the rest of the city. The introduction of CAVs could be a great opportunity to create more space for pedestrians and roadside green.

FRIEDRICHSTRASSE

The Friedrichstraße is located in Berlin’s central district “Mitte”, it is one of Berlin’s most popular streets known for its big variety of cultural opportunities and shopping possibilities. The Friedrichstraße runs from the northern part of old “Mitte” down south to the “Hallesches Tor” in the district “Kreuzberg”. Due to its north-southerly direction it forms important junctions with the east-western axes. The road is very narrow in comparison to other roads with a similar traffic volume and business density. The street segment around the train station Friedrichstraße is one of Berlin’s hot spots and is connected to many different kinds of transportation modes, such as the tram, the underground and the regional railway.

HUFELANDSTRASSE/BÖTZOWSTRASSE

The corner Hufelandstraße/Bötzowstraße in Berlin’s district “Prenzlauer Berg” is close to the park “Volkspark Friedrichshain” and is a mixed residential area with many small cafes and shops. It is very densely planted with trees and has a calm and welcoming atmosphere. It is dominated by local residents’ traffic. Through the introduction of CAVs there is a possibility of creating an almost car-free zone and eliminating the current difficulties in finding on street parking.

6.1 SCHLOSSSTRASSE - TEAM 1

Carl-Friedrich Eckhardt (BMW Group), **Sebastian Seelig** (BuroHappold), **Rita Cyganski** (German Aeronautics and Space Research Centre), **Vanessa Miriam Carlow** (COBE, TU Braunschweig), **Nico Grasselt** (eMO Berlin Agency for Electric Mobility), **Norbert Pauluweit** (BSR - Berlin Waste Management Authority)

Write-up by **Sebastian Seelig**

What is your team's idea?
Today, the Schloßstraße suffers from thoroughfare traffic between Berlin's Southwest and the city centre as well as from traffic generated by the large retail units. The team's work focuses on the idea of leveraging CAVs' increased vehicle capacity on roads to more effectively manage the traffic and hence improve the quality of the urban realm, especially for pedestrians and cyclists. Beyond this, the scheme should enhance the quality of life in the entire neighbourhood. Rather than proposing a full transformation of the area, the team proposes a set of careful interventions which will need to be implemented over a longer period of time as the technology evolves.

The first set of interventions focuses on the re-design of the Schloßstraße, with the three lanes being repurposed in the following way:

- one lane should be used by autonomous vehicles, including cars, buses, car sharing and ridesharing;
- one lane should be used for pick-up/drop-off areas, new stops for ridesharing and on-demand bus stops (every 300m); and
- one lane should be used solely by cyclists.

Narrowing down the lanes to 2.5m will free up additional space for extended and improved pedestrian space.

The lesser number of cars will also result in a more efficient use of parking infrastructure that in turn may be used for re-densification or to provide required recreational areas or social infrastructure. Another intervention centres around the upgrade of public infrastructure which might be under stronger competition in the future due to an increased use of ridesharing and car sharing.

Why is this a good idea for your city?
The design is a good idea because it provides multiple benefits for the most frequent users of the street and its adjacent residents. Firstly, the design significantly improves the quality of the urban realm, especially for pedestrians and cyclists. Pedestrians shopping in the Schloßstraße will benefit from broader sidewalks for a safer and more enjoyable pedestrian experience. A greener environment with more trees will lead to an enhanced microclimate, crucial in times of more frequent and longer heat waves. Redesigning the entire street space will also allow for an upgrade of the old 20th century infrastructure, introducing natural rainwater management through green infrastructure.

Cyclists using the Schloßstraße as a main transport spine to the south west of Berlin will enjoy a separate cycle lane with 2.5m width. The residents of the adjacent residential areas will benefit from reduced peak traffic, as service and waste vehicles will provide their services during evening hours and night time, with dedicated service areas for drop-off and pick-up. Residents of the adjacent neighbourhoods will also benefit from new social infrastructure on top of multi-storey car-parks that are no longer needed due to the higher utilisation of parking facilities. Public transport users will profit from the introduction of pick-up and drop-off zones for shared services and from an improved station design of the Walther Schreiber Platz Station, offering additional services such as a post office in the station and bicycle infrastructure.

What would need to happen to implement your team's idea?
The redesign of streets, public transport stations, and existing infrastructure (such as multi-storey car parks) will require substantial funds for implementation. The team's proposal is to introduce a pricing mechanism that will help generate sizeable funds while aiming to reduce the overall traffic on Berlin's streets. Hence, the team introduces the idea of dynamic road pricing, which should be rolled out for the entire city of Berlin, both implemented and operated by the City of Berlin. The price that the individual user pays depends on the size of the car, the distance travelled, the number of passengers on board, the emissions caused and the social status of the user. The more efficient the vehicle and the lower the distance travelled, the lower the price. Furthermore, by adding socio-economic criteria into the pricing model one can allow for the implementation of an inclusive approach. Monitoring data and payments will be done with mobile devices.

"Technically AVs could have conquered the streets of Berlin in 2025 to 2030. However, it is very much dependent on which framework conditions are in place in the city."

Carl Friedrich Eckhardt
BMW Group, Leader of the Centre for Urban Mobility

6.1 SCHLOSSSTRASSE - TEAM 1

6.2 SCHLOSSSTRASSE - TEAM2

Alan Harbinson (BuroHappold), **Dalia Levens** (BuroHappold), **Ludwig Engel** (UdK Berlin), **Roger Nickells** (BuroHappold), **Thomas Willemeit** (Graft Architects)

Write-up by **Dalia Levens**

What is your team's idea?
Our idea focused on the goal of maintaining and increasing the value of the urban environment through the use of AVs. We wanted to maintain and improve upon our location as a destination for shopping and a dense residential neighbourhood, while maintaining traffic access to Schloßstraße as a main thoroughfare. We have therefore envisioned a space in which technology is used to optimise operations of the roadways. With resident and customer parking abolished in the area, street parking space could be reclaimed for public or commercial uses. In addition, operational optimisation would allow us to shrink roadway profiles by narrowing lanes, narrowing turning radii, and potentially removing traffic lanes. A technological solution would allow optimal use of the remaining solutions, by digitally opening and closing lanes during periods of changed demand. Directions could also be changed to meet directional peaks as needed. Routing algorithms could also be used to change AV routing through the city at different times of day. In this way back streets could be used more when the neighbourhoods are more likely to be empty (i.e. during the midday), but vehicles would be routed along designated major streets to avoid interferences with neighbourhood activities. This could all be done in real-time to match current demand.

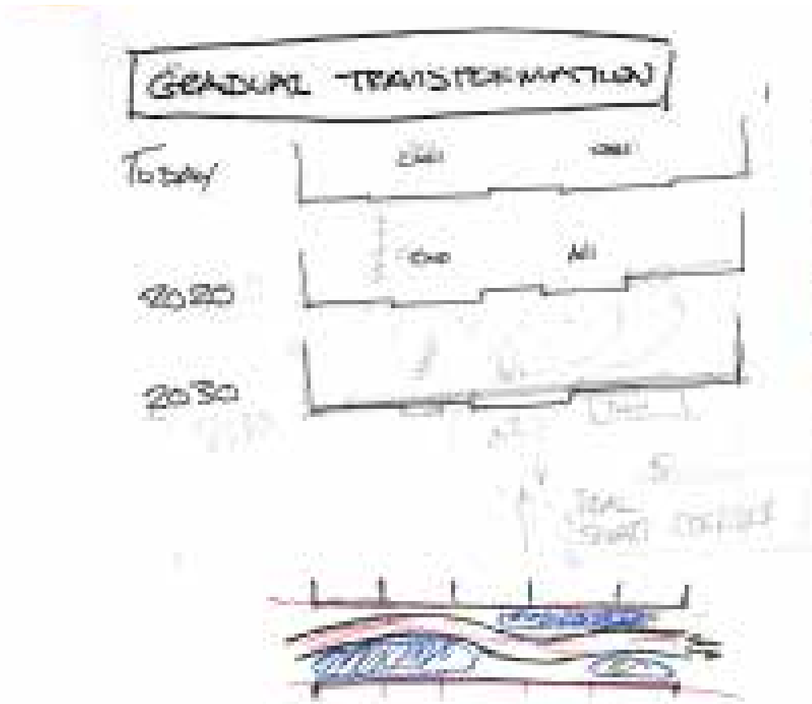
Why is this a good idea for your city?
This is a good idea for the site because it provides increased opportunity for economic growth, while simultaneously increasing the efficiency of the transportation network. It is our proposal for an area that is well served by public transit (including many U-Bahn (subway) stations and bus routes) to use some level of traffic congestion to encourage pedestrian activity and the use of transit in the neighbourhood, while improving access. Thoroughfare traffic can still be accommodated, but it is not the priority for this street. This technological solution would be highly adaptable, and would let the whole city – not only this neighbourhood – adapt to changing conditions in the most efficient way possible. This is also an evolutionary solution, that accommodates as much or as little change as might be needed, as people slowly start to change their behaviour.

What would need to happen to implement your team's idea?
Our basic assumptions included a fleet of 100% emission and noise free vehicles. That would reduce the impact that vehicles had on humans. We would require that within some predefined area, only pick-up and drop-off was allowed, so that no non-autonomous vehicles that need to be parked would be allowed in the area. This would not necessarily extend to the existing parking garages – if not redeveloped, perhaps these existing garages would serve as good locations for long-term storage of self-driving vehicles. The major requirement to implement this solution is a city-wide (or perhaps area-wide) real time traffic management system. This system would need to be able to monitor traffic conditions in real time, and be connected to the routing software of all AVs in the city, so that routing could be changed as needed.

"The really interesting departure from the norm is bringing together individuals from different professional backgrounds."

Alan Harbinson
Managing Director, Cities,
BuroHappold

6.2 SCHLOSSSTRASSE - TEAM2



6.3 HUFELANDSTRASSE - TEAM 1

Frank Christian Hinrichs (inno2grid), **Melanie Garcia** (BuroHappold), **Nicolas Pomränke** (gmp Architects), **Jörg Kirst** (ADAC - German Automobile Association), **Paul Rogers** (BuroHappold), **Ricarda Pätzold** (German Institute for Urbanism)

Write-up by **Melanie Garcia**

What is your team's idea?
Since the Hufelandstraße is located in a residential area, a significant part of the street is currently being occupied by parking lots. Our team assumed that the future of autonomous vehicles will include car-sharing fleets, ridesharing as well as privately owned AVs. We conceived a city full of autonomous vehicles as unrealistic.

In view of a future where autonomous driving does however become a reality, our team assumes that the use of CAVs will ease the neighbourhood's on-street parking demand and therefore proposes to make use of the no longer needed parking space for other neighbourhood functions. The concept for the reuse includes community gardens, playgrounds, temporary use spaces and drop-off areas for the autonomous cars that attend service purposes.

As retail outlets such as supermarkets might no longer exist in the future, the street would also need to be able to accommodate the increasing number of deliveries by autonomous vehicles. This not only poses a technological challenge, but also requires a range of policy changes.

The team's main assumptions regarding the street design are as follows:

- One lane will remain reserved for on-street parking, especially for individually-owned cars. The dimension of the lane will remain the same (about 2 meters) as we anticipate this lane to be used by both CAVs and traditional cars.
- One lane will have 2 drop-off areas at either side of the street for CAVs attending service purposes (groceries and other deliveries) as well as parking space for car-sharing. In this lane different urban functions can take place such as community gardens, playgrounds, shared spaces and temporary use spaces that adjust to the neighbourhood's needs and preferences.
- The car circulation space of the street will be gradually reduced until normal cars slowly leave the grid, releasing space for pedestrians, cyclists and the above-mentioned urban functions.

Our concept can best be explained with a series of transitions that would be phased as people get used to autonomous and connected vehicles. Hufelandstraße is a street with on-street parking on either side. The team therefore proposes to leave one street side open for on-street parking while developing the other side during a first phase. In a second phase, the on-street parking would be closed on both sides, allowing for the appropriation of space by the community.

Why is this a good idea for your city?
Freeing up space in a residential area would allow citizens to reclaim the street as their public space. This translates into an increased quality of the urban space and in turn into a better quality of life for the residents. Through community participation residents will play a main role in the development of these public spaces, since they will be able to decide what kind of activities they would like to see taking place at the sites. Our team foresees these spaces as "flexible spaces" that will change over time as autonomous driving evolves. This, along with a phased approach, will ease the process for both residents as well as the urban fabric. At the same time, the residents' mobility will be increased, since the idea conceives an integrated transport system in which CAVs will be key, especially for people with reduced mobility.

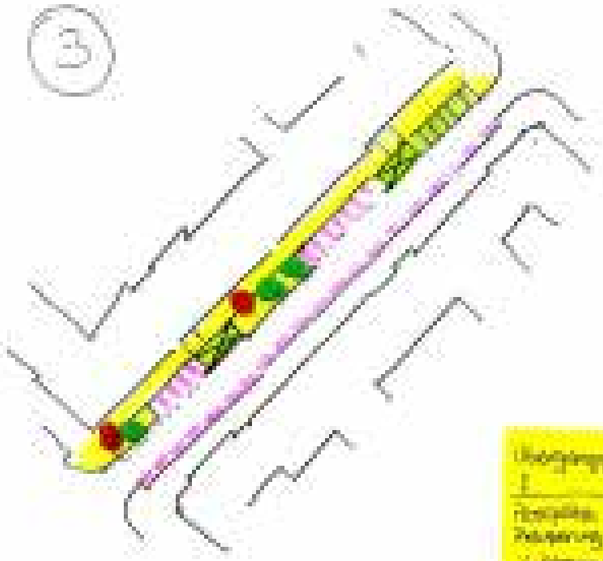
What would need to happen to implement your team's idea?
As the planned space belongs to the government, the re-development of the street would have high costs for both the citizens and the government. To implement our idea, the autonomous vehicle companies should contribute to the financing of the transportation hubs within the city. The team also foresees the implementation of regulative policies that allow the cooperation between public transport authorities and CAV companies. This will be key for the success of an integrated transport system.

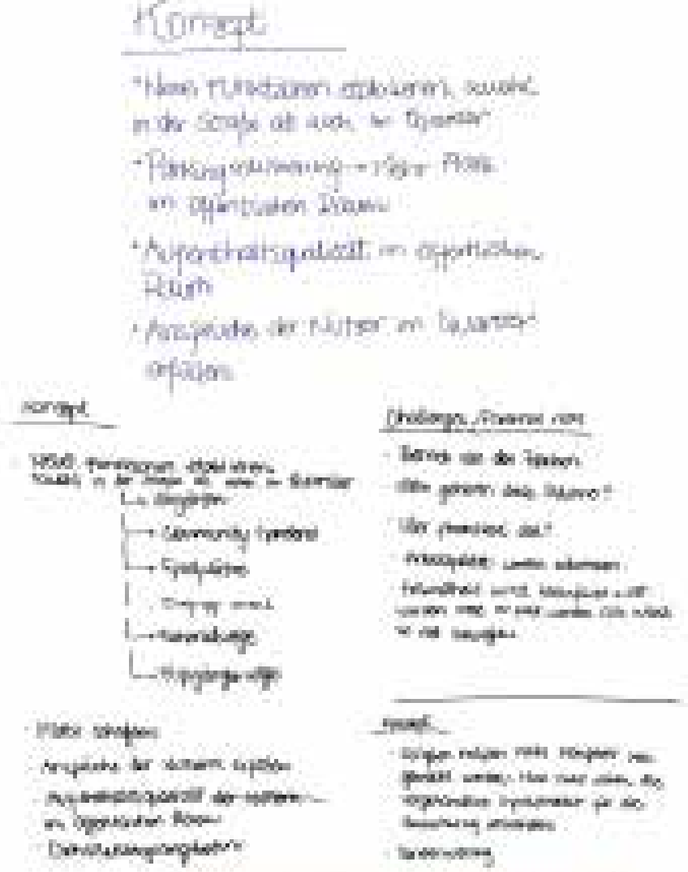
Through the phased approach (led by regulative policies), the demand of traditional cars will slowly be reduced, since it will be more difficult to park a traditional car within the city. In this way, the transition process may be accelerated.

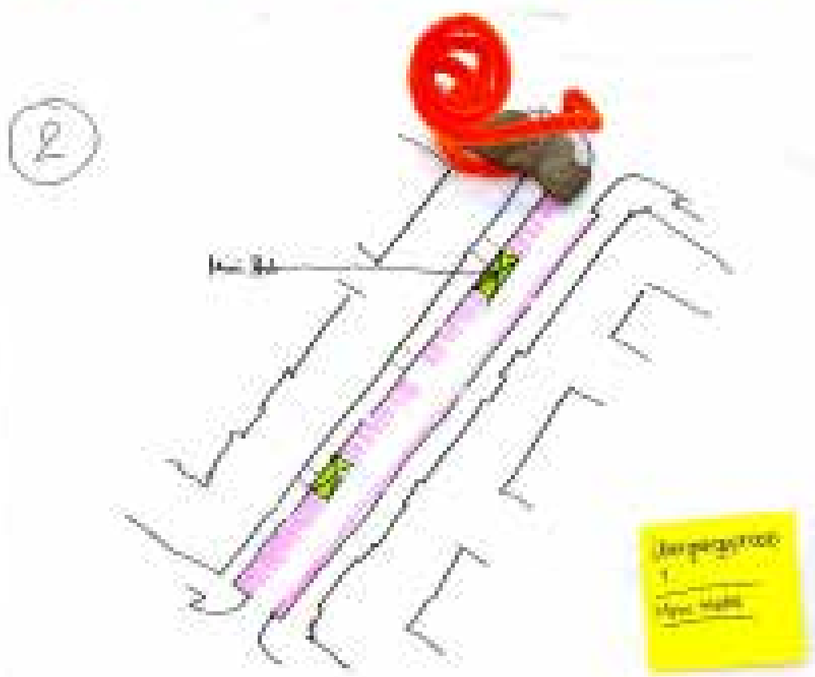
"It was really a sprint getting straight into the heart of the challenge."

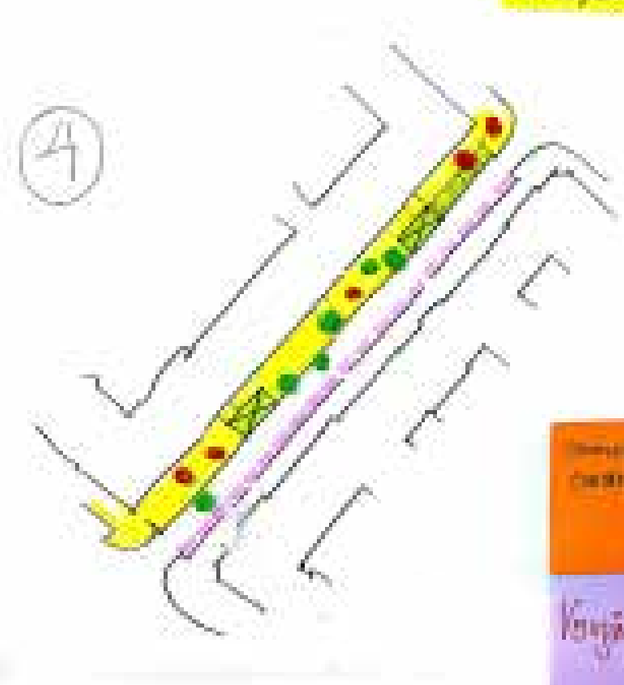
Ricarda Pätzold
Researcher at the German Institute for Urbanism,
Department Urban Technology, Law, Social Affairs

6.3 HUFELANDSTRASSE - TEAM 1









6.4 HUFELANDSTRASSE - TEAM 2

Burkhard Horn (Berlin Senate Department for the Environment, Transport and Climate Protection), **Christian Roth** (zanderrotharchitekten), **Doris Lohrmann** (Local Motors), **Ellen Kallert** (bbz landschaftsarchitekten), **Richard Kemmerzehl** (inno2grid), **Jochen Rabe** (BuroHappold, Einstein Center Digital Future)

Write-up by **Jochen Rabe**

What is your team's idea?
Our starting point was the statement that Hufelandstraße, as a mostly residential inner city location, is already well connected to various modes of public transport. Hence, the focus of the discussion was how to position autonomous driving as an added value, whilst avoiding cannibalism of the other forms of public transport which should have priority over autonomous driving offers. We suggest that complementary CAV services will be operated by public transport companies to ensure that the CAV technologies add new qualities to the overall multimodal transport, without replacing more sustainable forms of mobility (e.g. metro, trams and buses). The team was adamant that future modal mixes utilising CAVs must not generate more trips congesting our streets, but less (provided the population number remains unchanged).

The idea is to use the opportunities provided by autonomous driving to further unlock the qualities of the neighbourhood as a home to hundreds of Berliners. Key to the design is the desire to declutter the streets of the neighbourhood, assuming that sharing and autonomous driving services for both people and goods will significantly lower the ratio of car ownership and the number of cars parked on the streets. The team therefore suggests to gradually introduce parking restrictions and eventually free the streets of resident owned cars by 2030. The unlocked public space will be used to increase the share of green space, improving both the climate and the spatial qualities of the neighbourhood.

A mobility hub placed at the edge of the neighbourhood at the Arnswalder Platz, yet within 10min walking time will provide two main functions. Firstly, it will connect the neighbourhood to the full mobility mix of the borough and wider Berlin. Secondly, the hub as one key arrival point to the area will function as an access point to neighbourhood services such as the Neighbourhood Autonomous Shuttle Bus, last mile delivery services for shopping and other goods etc. By concentrating these services at one location at the edge of the neighbourhood, the team would like to avoid merely replacing space previously occupied by car parking, with space allocated to CAV services ("Driving cars, classic or CAVs shouldn't be too comfortable!"). The team acknowledges that the careful distribution of drop off points and parcel stations connected by CAV services and designed into the neighbourhood's public realm will increase the comfort for residents. The "Olli Neighbourhood Shuttle" is seen as the main CAV service provided within the area, however additional autonomous driving services from outside of the neighbourhood need to be considered, given that they follow the general principles for CAV services set out above. These external services should focus on connecting to the neighbourhood mobility hub and hence increasing its efficiency.

Why is this a good idea for your city?
The implementation of the ideas introduced above would allow the provision of significantly more public and green space whilst maintaining and improving the currently good levels of accessibility and mobility to the citizens. In particular the provision of additional green space in the streets is seen as important, because it currently is below its desirable standards, despite the otherwise reasonably high architectural quality of the neighbourhood. The team's strategy would include two major benefits to the neighbourhood: The activation of the streets would introduce numerous public activities in the streets critical for the wellbeing of residents and to the local identity building and community participation. The additional green space would mitigate local and global environmental challenges such as nitrogen dioxide and particulate matter emissions, as well as climate change impacts such as heat waves.

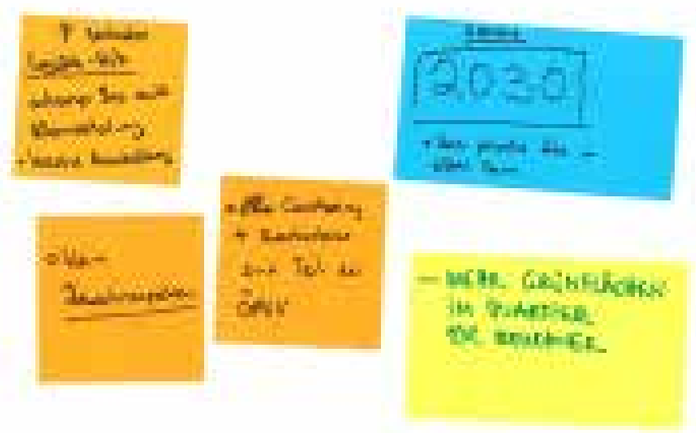
The team discussed further, considering more radical approaches on how to capitalise on the increased and higher quality provision of space and services in the streets. The team thinks that this would principally allow to further increase the density of neighbourhoods through the provision of additional dwellings on top of existing buildings or gaps in the urban fabric. However, due to the architectural quality of the neighbourhood the team was hesitant to deploy this strategy in this neighbourhood.

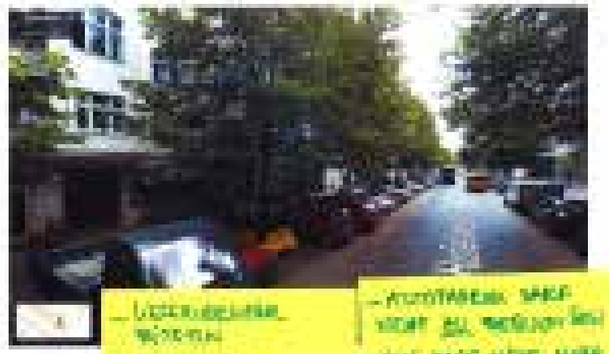
What would need to happen to implement your team's idea?
The team acknowledges that regulation is key to introduce a sustainable mobility mix including the harnessing of CAV services. Phasing out resident parking would need regulation, allowing the residents to adapt over time. This would include measures such as the provision of less parking space, increasing the costs of resident parking (the Berlin prices were considered to be far too low compared to already existing pricing systems in other cities such as, for example, Amsterdam) and eventually the ban on any form of parking for privately owned cars. The team suggests to immediately drop the speed limits in the neighbourhood to 10kph and to try to restrict trips generated by delivery traffic possibly through the tendering of exclusive neighbourhood delivery services.

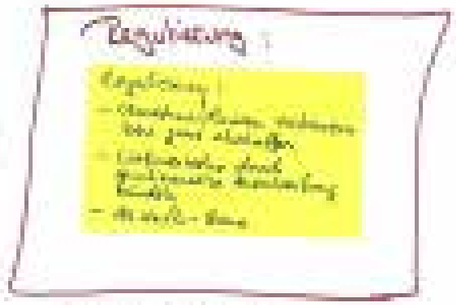
"If Berlin voluntarily submits itself to AVs, it would have to be in a regulated way. The goal is not only to have less parked cars, but also a reduction of individual traffic whilst strengthening public transport."

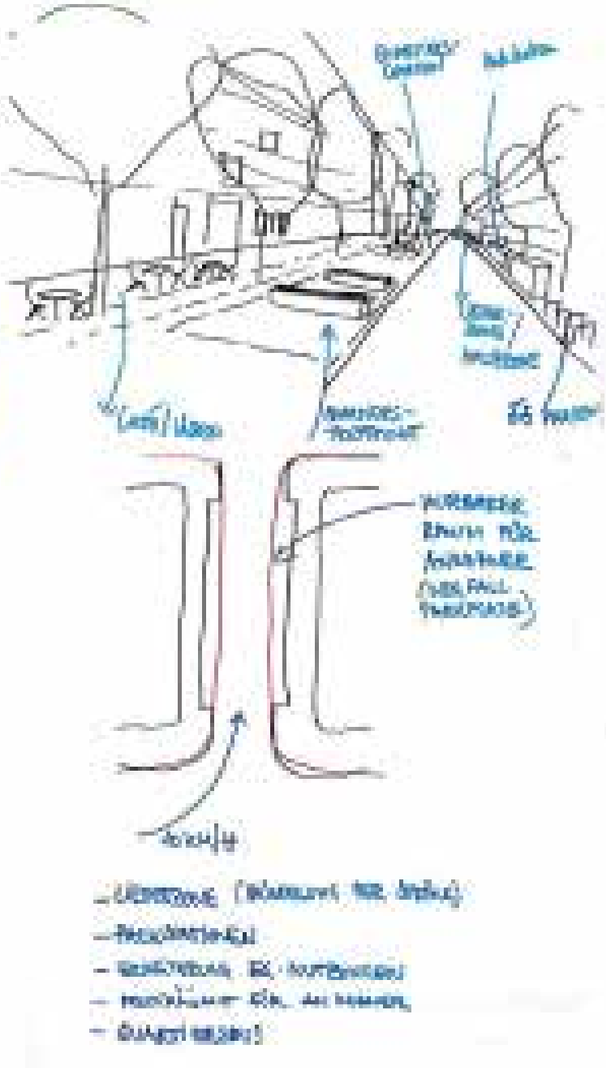
Burkhard Horn
Head of Traffic, Berlin Senate Department for the Environment, Transport and Climate Protection

6.4 HUFELANDSTRASSE - TEAM 2









6.5 FRIEDRICHSTRASSE - TEAM 1

Anne-Caroline Erbstößer (Foundation Technologiestiftung Berlin), **Hendrik Wüst** (BVG - Berlin Public Transport Corporation), **Öykü Ülgüner** (BuroHappold), **Thomas Stellmach** (TSPA Planning and Architecture), **Ute Klotzbücher** (BVG - Berlin Public Transport Corporation), **Xavier Vagedes** (Bosch)

Write-up by **Öykü Ülgüner**

What is your team's idea?
Friedrichstraße is one of the most crowded central streets of the city. Our team's main goal was to maintain and improve the quality of the streetscape for pedestrians (mainly tourists and people who work in the area); and to reclaim the street for those who spend time "on the street".

In order to follow this target, we assumed that autonomous cars will reduce the intensity of traffic on the street. Therefore, we propose to reduce the space for cars and thereby increase the space for people to sit in cafes and restaurants on either side of the street. We also propose to use some of the reclaimed street for open and green spaces. While we considered options around different levels for traffic (cars on the top, public transport on the ground), we propose a one-level solution that organises the traffic into a single lane: An LED-ground lighting system will guide the traffic – a solution that also increases the visual quality of the street.

Why is this a good idea for your city?
The idea will improve the quality of place and increase the accessibility of the shops, offices, and recreation spaces for people. It also considers and appreciates the continuing role of public transport. The Friedrichstraße station, already a hub for different transport options will be maintained and improved. This concept is a good idea as it acknowledges the important features of the street and highlights the features of autonomous driving that are contributing to the sustainability of the area and its "human scale".

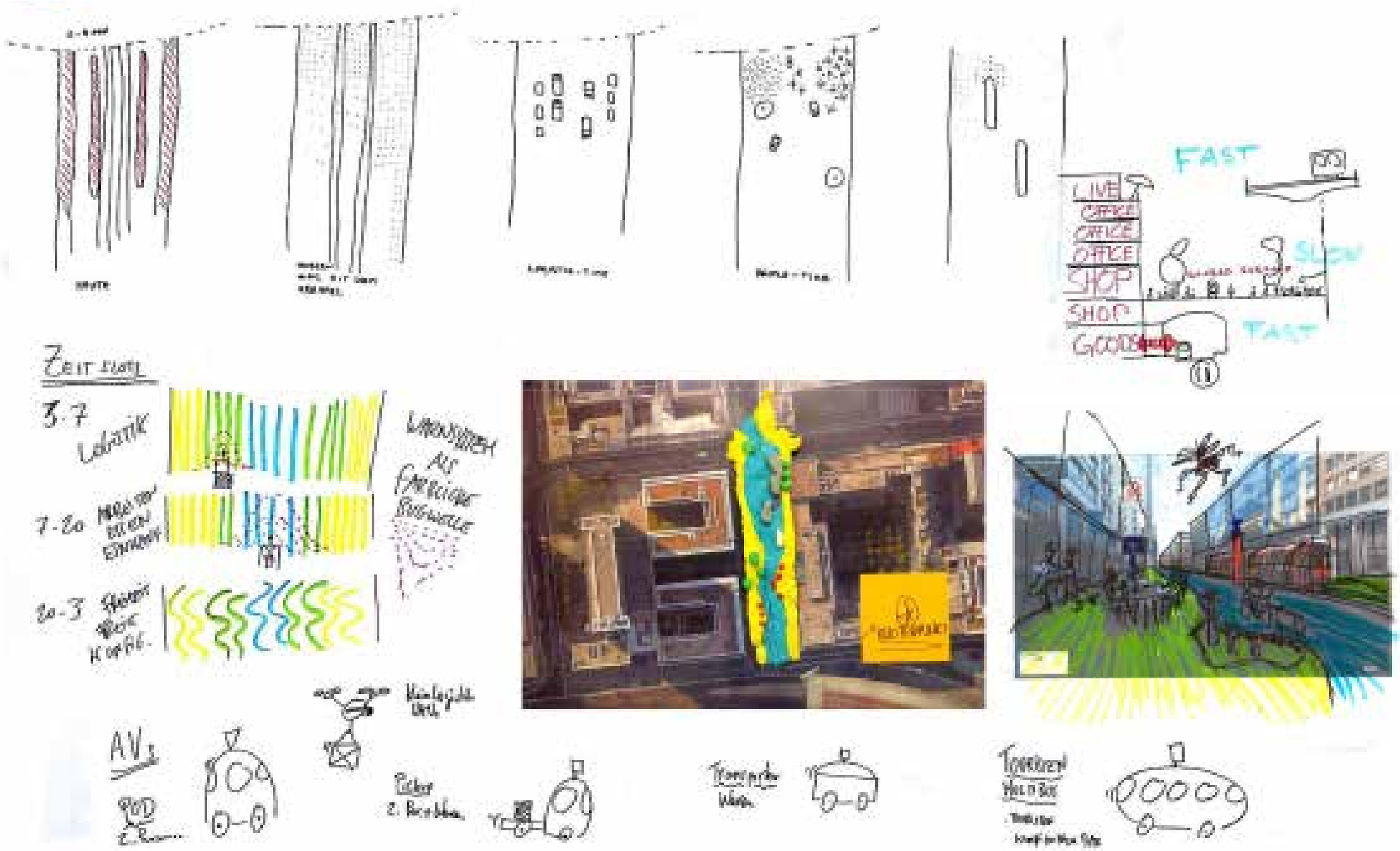
What would need to happen to implement your team's idea?
The team was relatively realistic about the implementation when coming up with ideas but identified a point in the future where many of the foreseen innovative technological solutions that are discussed today are assumed to be in use. For example, new product delivery services including drones and smart systems are considered to be a main part of logistics in the future, which will cause a decrease in the volume of traffic on the street.

Another aspect is the policy regulations in terms of the cooperation with the public transport authorities and the autonomous car-companies in terms of creating hubs for transportation. It is not strictly defined by the team whether the autonomous cars will be privately owned cars or always under the control of large companies or bodies - the idea considered both options.

"The car has defined the urban shape and our cities as we know them today. This means that the cities change with the modes of transport."

Thomas Stellmach
TSPA Planning and Architecture

6.5 FRIEDRICHSTRASSE - TEAM 1



6.6 FRIEDRICHSTRASSE - TEAM 2

Benjamin Scheerbarth (Eckwerk Entwicklungs GmbH), **Peter Specht** (ADAC - German Automobile Association), **Boris Dehler** (Die Grünen), **Nadine Kuhla von Bergmann** (TU Berlin, Smart Sustainable District Moabit), **Thomas Kraubitz** (BuroHappold, DGNB)

Write-up by **Thomas Kraubitz**

What is your team's idea?
Using the right space for the right function made us consider blocking off parts of the Friedrichstraße for all vehicular traffic – as is currently proposed by Berlin's Green Party. By doing so, drop-off areas become more important and might come to be the true "intermodal exchange and orientation" points within the city.

We looked closely at the intersection between the Friedrichstraße and Unter den Linden where vehicle traffic will be rerouted. At this location, we imagine that people will change from a motorised vehicle to bicycle or continue on foot. At the same time, there may be drones, postal drop-offs, etc. enhancing these areas as an exchange on various levels. Free WLAN and other forms of connecting – including meeting people – are included.

Removing vehicles from parts of the street frees the space between buildings and across streets, this space can be used for outdoor activities and will strengthen the spatial relationship across the street – exchange becomes possible.

On the strip between the Friedrichstraße Station and Unter den Linden, we suggest utilising the non-traffic intervals of the trams for autonomous vehicles, allowing them to cut in and to thus exploit the space between trams – where speed limits might even be lifted.

Further South – between Friedrichstraße and Leipziger Straße we suggest a so-called 'Lens', defining a drop-off space where cars unloading passengers will not block passing traffic and ultimately leading to a reduction in traffic.

Why is this a good idea for your city?
We see three specific benefits of the concept:

- By combining the lane for the tram with a lane for autonomous and connected vehicles, the currently not fully utilised corridor will be used more efficiently.

- Pedestrianising the Friedrichstraße allows for more pedestrian and exchange space where people and deliveries get dropped off and picked up.

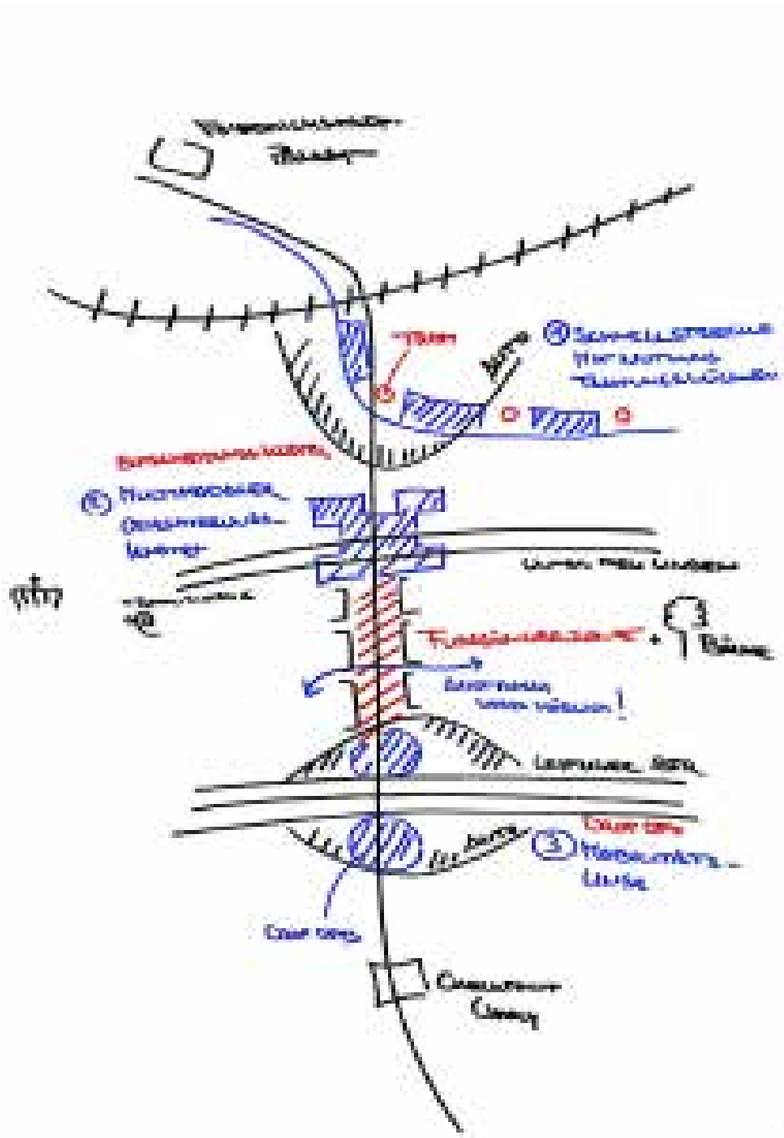
- There will be no intermodal station, but a series of decentralized intermodal nodes.

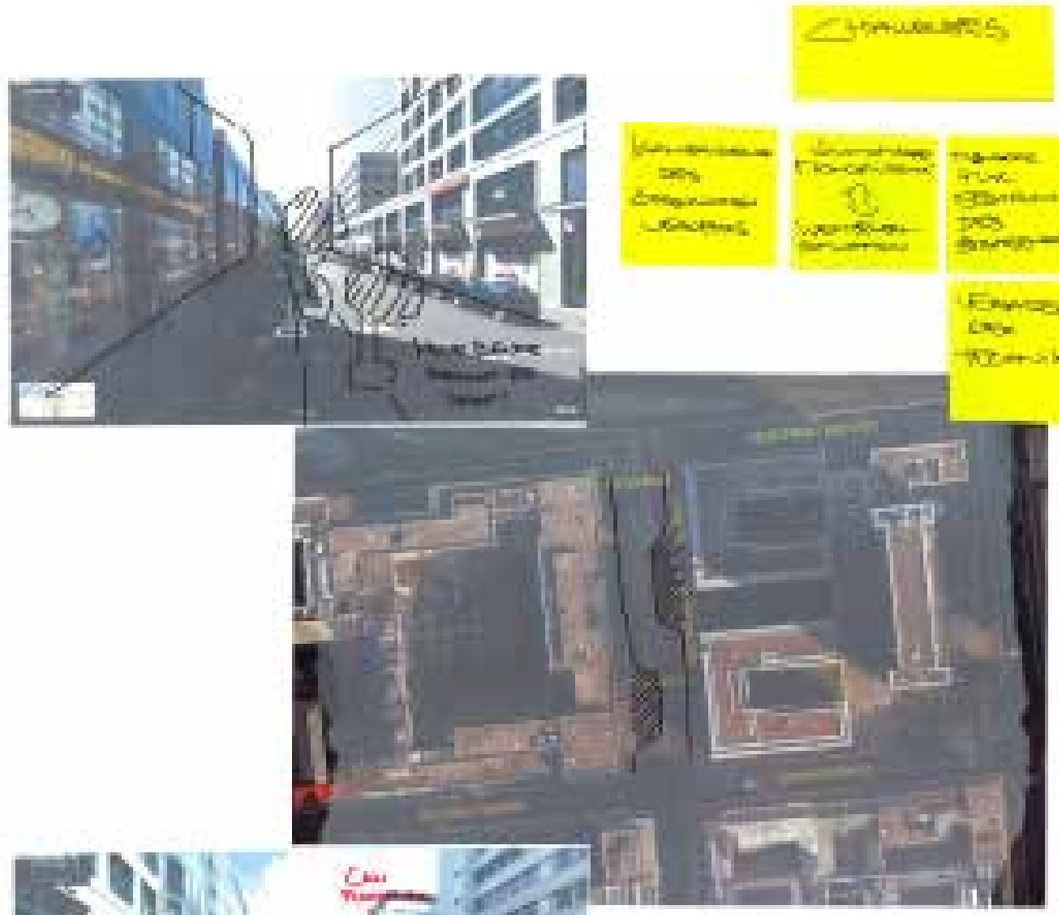
What would need to happen to implement your team's idea?
In a first step, we suggest following the proposal of the Green Party to make parts of the Friedrichstraße a pedestrian street. In order to use the tram tracks for autonomous vehicles, the times need to be coordinated with the public transportation authority. Finally, the intermodal exchange spots need to be defined.

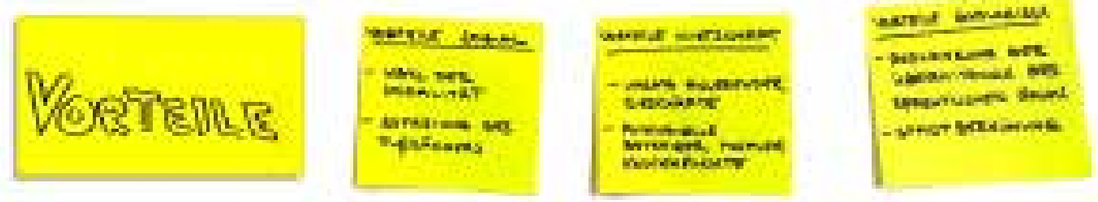
"Autonomous vehicles are not just a revolution in mobility but also a revolution for urban space."

Thomas Kraubitz
Associate BuroHappold and DGNB Auditor

6.6 FRIEDRICHSTRASSE - TEAM 2







LONDON : JANUARY 19 2017

7. LONDON SPRINT

As with many cities globally, London's population is growing at a rapid rate – with a transport infrastructure dating back centuries. As this trend continues, journeys between homes, places of work, and places of leisure will play a key role in the city's ability to successfully adapt to these demands on density and scale. London's current transport strategy includes aims for leading the world in its approach to tackling urban transport challenges; and to reduce the city's CO2 emissions by 60% by 2025 – so not only is London well-placed for a Sprint on CAVs, it also has access to many of the stakeholders that will be involved in delivering the city's vision.

Euston Road is one of the most unpleasant thoroughfares in London – both for drivers and pedestrians. Its central connecting function from Regent's Park, via Euston to King's Cross makes it extremely busy throughout the whole day. Reimagining this multi-lane streetscape with the unattractive pavement for the age of CAVs might offer both to car-drivers and pedestrians a more enjoyable passage through this road. Waterloo Bridge is a central element to linking major tourist areas north of the Thames, such as Covent Garden, with Southbank. Regardless of the bridge's central role, it is purely dominated by the car and enjoying the great views is rather unpleasant. How might bridges be rethought and used in previously unimagined ways in the age of CAVs? Old Street Roundabout is a central node in east London, where major roads from all cardinal directions come together. The massive extent of this roundabout creates an awkward space in the middle with little appeal to linger. The age of CAVs might transform the whole interchange and give both street and island a new, interlinked purpose.

The London Sprint was attended by 30 people from organisations and institutions like City of London, Milton Keynes Council, Institute of Civil Engineers, ARUP Foresight, Gensler, Transport Research Laboratory, UCL, Gustafson Porter + Bowman, Greenwich University, Living PlanIT, DG Cities, Farrells, Siemens – amongst the 6 teams were 13 members of BuroHappold staff. We hosted our Sprint in the London's office, where Alan Harbinson, Managing Director Cities, greeted the participants. Robert Moyser, Director Urban Futures, then introduced the day's Sprint subject and facilitator, Robert Mayers. Jeremy Dalton from Travel Spirit and Lucy Lu from the Department for Transport's Centre of Connected and Autonomous Vehicles kick-started the day by refreshing the participants' memories with two informative flash presentations around some of the current (and future) situation of connected and automated vehicles. Directly after this, the participants started sprinting!

True to its name, the Sprint was followed by the participants with energy and momentum, and generated some exciting (and some novel) ideas, that responded to their London sites by thinking about street features, the types of CAVs, and most importantly, the citizens. Waterloo Bridge was to become the river's "Third Bank", while connecting a cluster of attraction of Covent Garden. Euston Road was to connect our bodies, health, and fitness to a "BioMobility" network. And 'dynamic' was to become the "New Old (Street)", with a vibrant, user-driven flexible space. The London Design Sprint was received with curiosity and enthusiasm, and by providing participants with the conditions to work towards a shared challenge, the process succeeded in galvanising the interdisciplinary teams. Andrew Comer, Director Cities, concluded the event by stressing the emerging significance of the CAV industry, and reminded the attendees that they were the people who will have the power to influence this disruptive technology. Finally, the London event was closed with Andrew's wish that, the attendees' discussion on the subject of connected and automated vehicle should continue, and moreover that the collaborative design sprint format will return - in future iterations.

LONDON : SITES FOR STUDY

LONDON: WHY HAVE WE CHOSEN THESE SITES?

EUSTON ROAD

Euston road is one of the most unpleasant thoroughfares in London – both for drivers and pedestrians. Its central connecting function from Regent's Park, via Euston to King's Cross makes it extremely busy throughout the whole day. Reimagining this multi-lane streetscape with the unattractive pavement for the age of CAVs might offer both to car-drivers and pedestrians a more enjoyable passage through this road.

WATERLOO BRIDGE

Waterloo Bridge is a central element to linking major tourist areas north of the Thames, such as Covent Garden, with Southbank. Regardless of the bridge's central role, it is purely dominated by the car and enjoying the great views is rather unpleasant. How might bridges be rethought and used in previously unimagined ways in the age of CAVs?

OLD STREET ROUNDABOUT

The Old Street Roundabout is a central node in east London, where major roads from all cardinal directions come together. The massive extent of this roundabout creates an awkward space in the middle with little appeal to linger. The age of CAVs might transform the whole interchange and give both street and island a new, interlinked purpose.

7.1 WATERLOO BRIDGE - TEAM 1

Giacomo Magnani (BuroHappold), **Jonathan Broderick** (ARUP Foresight), **Noorvir Aulakh** (University College London), **Petros Ieromonachou** (Greenwich University), **Sabina Uffer** (BuroHappold)

Write-up by **Sabina Uffer** & **Giacomo Magnani**

What is your team's idea?
Waterloo Bridge is a key south-north connection across the Thames. At one end of the bridge is Waterloo Train Station, one of the busiest commuter train stations in London. At the other end, the bridge connects to Covent Garden and the theatre district. Traffic flow is often congested at either end of the bridge, mainly due to last minute lane changes. The bridge is famous for its iconic view to the Parliament and Westminster in the east and St. Paul's cathedral and the City of London in the west. For pedestrians, however, the experience of what could be one of the most scenic public spaces in London is jeopardised by the traffic and congestion on the sidewalks. Our team's goal thus was to leverage the introduction of autonomous and connected vehicles as an opportunity to release the potential of the bridge as a public space.

We believe that the introduction of CAVs will improve the traffic flow at either side of the bridge and increase the capacity of each lane. For this reason, we think we can permanently reclaim some of the space on the bridge for pedestrians. Without creating a new heavy structure on the bridge, we propose to have a cycle highway and two lanes for autonomous vehicles (one for either direction) on the east side of the bridge. At either end of the bridge we would open it up to four vehicle lanes again, where two would be used for drop off and pick up – charged a fee per second to prevent idling by cars.

This would provide enough room on the west side to create a vibrant urban space for pedestrians to experience the view over the railings. In order for pedestrians to also enjoy the view towards the east though, we propose to have a light elevated structure under which there will be shops and cafes and where stairs would lead up to the rooftop of these shops that function as a viewing platform.

Why is this a good idea for your city?
Creating a public space over the bridge will provide an unprecedented experience for pedestrians and tourists with relatively little intervention and cost. It will also be a historical reference to the London Bridge that was once packed with commercial spaces. Looking at the wider urban system, the bridge will act as a "Third Bank" and connect the cluster of attraction of Covent Garden with the ribbon of venues on the South Bank.

We thought about the project's viability and suggest that the rents from the retail and restaurants will help keep up and maintain the public space. The attractiveness of the new space will eventually increase the footfall on the bridge itself and between the two sides of the river, with positive impact for the local economy. In addition, the dynamic routing on either side of the bridge will release congestion and create a better urban space.

What would need to happen to implement your team's idea?
The technology of autonomous vehicles would need to be advanced enough for vehicles to connect to each other and to the infrastructure of the dynamic routing system, which would understand where each car wants to go and accordingly put it in the correct lane at either end of the bridge. The intervention in itself is however relatively minimal and cost effective as we envision the elevated structure to be made of steel and/or wood. We would need some funding to cover the initial capital costs, but maintenance of the space would be covered by the rental revenue from the retail spaces.

"A very interesting way of running a workshop and generating ideas for possible solutions to problems. It was interesting to hear such varied viewpoints between backgrounds and specialisations of each participant. I also like it because it is directly transferable to a classroom."

Petros Ieromonachou
Greenwich University

7.1 WATERLOO BRIDGE - TEAM 1

7.2 WATERLOO BRIDGE - TEAM 2

Andy Murdoch (BuroHappold), **Emmanuel Ojugo** (City of London), **Katie Adnams** (City of London), **John de Campos Cruz** (BuroHappold), **Juliette Aplin** (BuroHappold)

Write-up by **Juliette Aplin**

What is your team's idea?
Our team explored the opportunities to reclaim public space assuming that autonomous cars are more efficient and therefore, more space becomes available for bike lanes, green spaces, pedestrians, and even leisure and tourism. Set in the context of 2030, our concept is branded "tidal-tainment", representing the idea of adaptability of public space to accommodate a diverse and changing range of entertainment, transport and tourist-friendly activities.

We reimagined Waterloo Bridge to become a flexible public bridge, subdividable into six equally wide lanes, and able to respond, recede, and expand according to demand from commuters, tourists, cyclists and vehicle traffic. Sensors within the bridge monitor the demand from different activities, and allocate lanes accordingly (to CAVs, pedestrians, bikes, and for public or entertainment space). By removing the fixed lane system, we have the flexibility to mix and diversify the use of the bridge, and enable tourists traveling between Covent Garden and the Southbank to enjoy the spectacular views across the Thames.

Project aims:

- Create a flexible, dynamic use of public space
- Integrate multiple activities crossing the bridge, in a safe and enjoyable environment (commuters, cyclists and tourists) – demonstrating that these activities can co-exist without conflict
- Introduce entertainment CAV pods, linking Covent Garden and the Southbank, hosting various uses
- Create an iconic and technologically pioneering bridge for London
- Use dynamic traffic management systems and sensors to inform intelligent wayfinding and signage

CAVs will be operating at different speeds, separated into lanes. Some CAVs will carry traffic across the bridge, others will be non-conventional pods, opening up new entertainment activities: small enterprises could host pop-ups or plug-in events such as AirBnB insomnia-soothing pods, café-pods, or a mobile registry-pod hosting marriages with London's riverside as a backdrop.

Why is this a good idea for your city?
Autonomous and connected vehicles greatly reduce the opportunity for human error and road accidents. They also operate more efficiently, requiring less lane space, and allowing more space for pedestrians and cyclists. In the context of Waterloo Bridge, this enables visitors to fully enjoy the spectacular views either side of the river, in a much safer and less polluted environment.

The entertainment CAVs or pods introduces an innovative new entertainment 'zone' to London, drawing tourists and their spending power to the area.

By using intelligent design, and a network of connected sensors, this bridge can become a public space which is regulated by design rather than decree. It can become a space that is intelligent, responsive, and reprogrammable.

What would need to happen to implement your team's idea?
Integrated dynamic traffic management systems and interactive wayfinding: These are essential to the idea's success. Responsive and interactive information panels across the bridge would inform everyday users and tourists how the lanes are to be used during the visit – i.e., how many lanes are currently pedestrianised or designed for CAV use. This serves to reassure visitors who may not be used to the idea of multiple activities existing in close proximity, and can guide them on using the space safely.

Real-time updates, utilising GPS, WIFI, apps, crowd sourced data, will be used to monitor capacity across the bridge. Certain thresholds of cars vs. pedestrians will have to be established to ensure these activities are kept within workable levels. This raised questions which are yet to be resolved: How to decide who has priority: Commuters or tourists? Cars or pedestrians? As a starting point, we have established that the two outer lanes will be reserved for pedestrians / activities, and a minimum of two lanes will be reserved for traffic at any point, until further analysis.

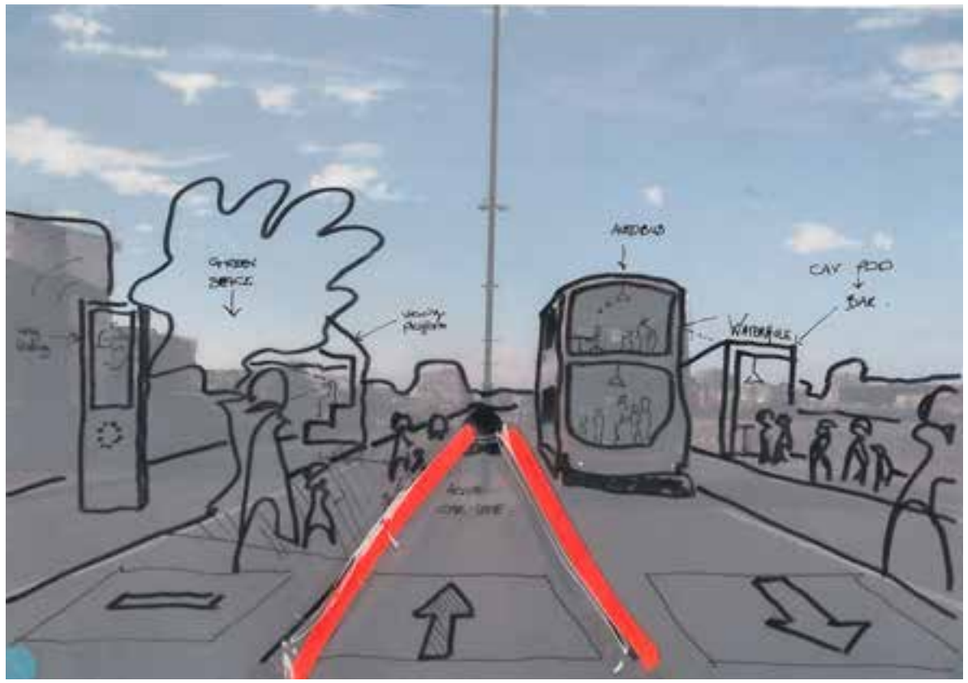
Governance and data infrastructure for the Bridge:
A new level of infrastructure or governance is required to coordinate CAVs, similar to Air Traffic Control. This raised many questions: what skills are required to establish and maintain this? Would this be automated, or a new opportunity of skilled employment? How will this be integrated into the wider public transport system?

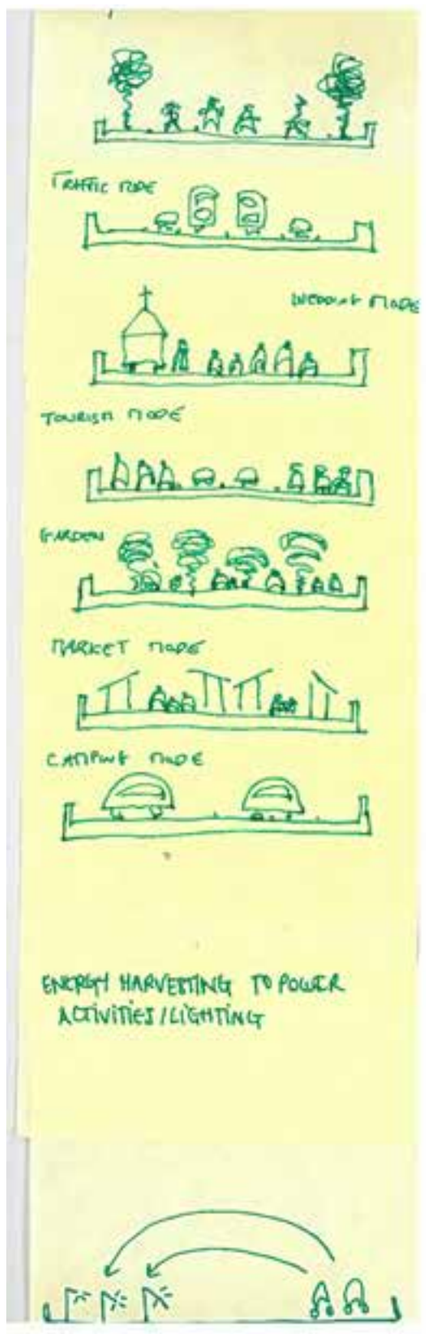
Regulation and Policy:
The bridge does not fit into the definition set by the Highways Act 1980 – so would have to be re-designated as a specific exception – maybe even requiring new legislation: the CAV Zone Act 2029! Significant political buy-in would be required to champion this pioneering and innovative use of public space. Again, this novel idea highlights further issues to be addressed: How to work with Black Cab drivers, and the conflict between CAVs and black cabs? Will this bring a loss of jobs in the capital?

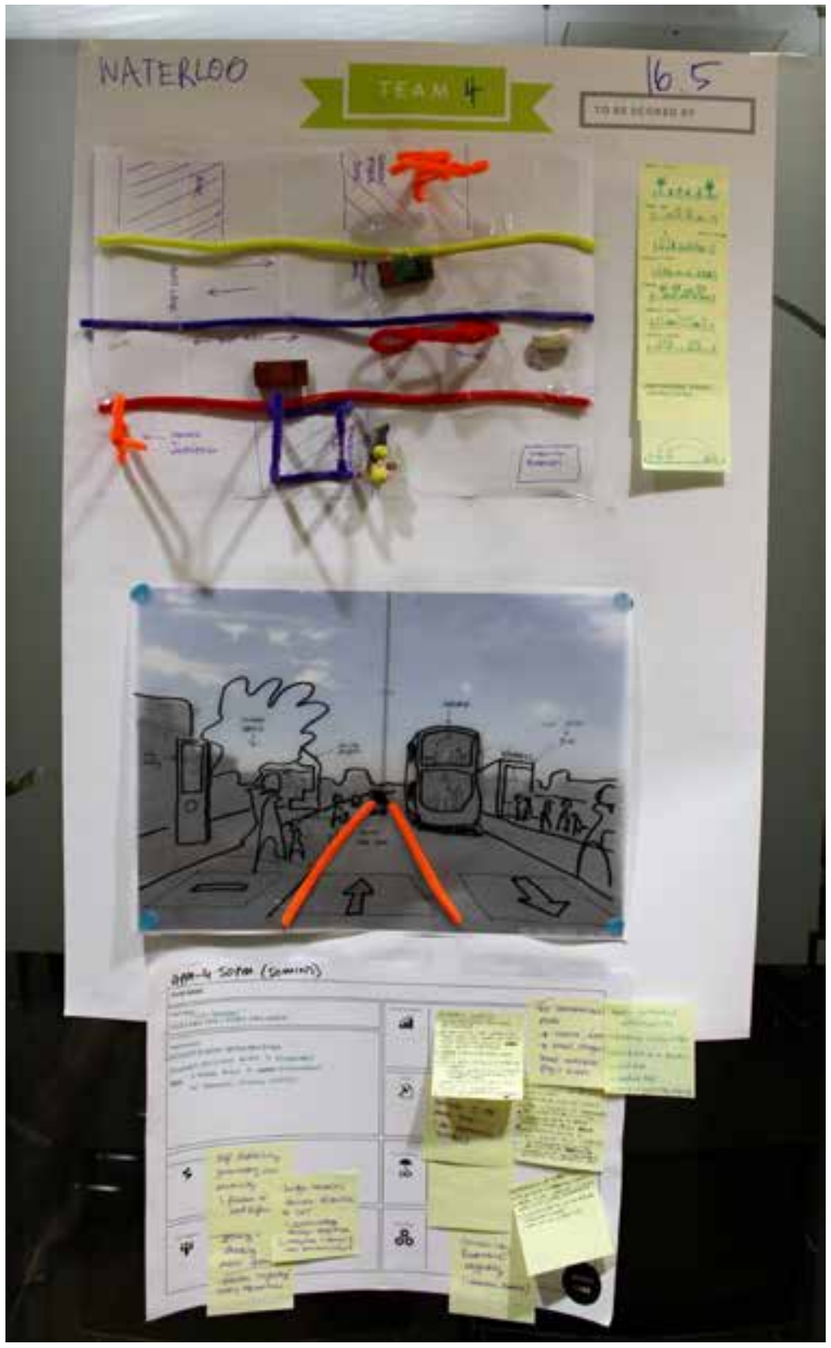
Raising funds and investments:
Whilst the initial investment needed to create the infrastructure for this bridge is high, the idea does bring economic benefits. IT provides the space for small businesses and enterprises to hire a pod, or set up pop-up stalls along the new bridge promenade. The novelty of the space will surely attract tourists and high levels of footfall. Significant sponsorship and branding opportunities would also be sought.

> *"Autonomous vehicles allows for certain things to be consolidated. Some of the journeys can be rationalised by more accurately measuring and responding to the actual activity in the city, which would also allow more people to be carried at once."*
>
> **Emmanuel Ojugo**
> City of London

7.2 WATERLOO BRIDGE - TEAM 2







7.3 EUSTON ROAD - TEAM 1

Alan Harbinson (BuroHappold), **Anna Rothnie** (BuroHappold), **Grant Gibson** (Milton Keynes Council), **Jeremy Dalton** (Travel Spirit), **Michaela Winter-Taylor** (Gensler)

Write-up by **Anna Rothnie**

What is your team's idea?
Our proposal is called "BioMobility" and based on discussions around how we can embrace autonomous vehicle networks as the lifeblood of London, as well as connecting them personally to our own bodies, health, and fitness. We propose to turn Euston Road into a dynamically changing space, with roads dynamically winding around public spaces that are being used for activities and events. These public spaces would be owned by the City and could be rented out to local businesses who want to use the space.

Our site, Euston Road, is a thoroughfare passing by one of the main intermodal hubs of the UK – Euston Station. We propose to have a number of "drop-off zones" where only public transport or CAVs that pay an inflated fare are able to stop within. This would encourage anyone coming to Euston Station to travel by public transport as it will ultimately be cheaper and get them closer to their destination.

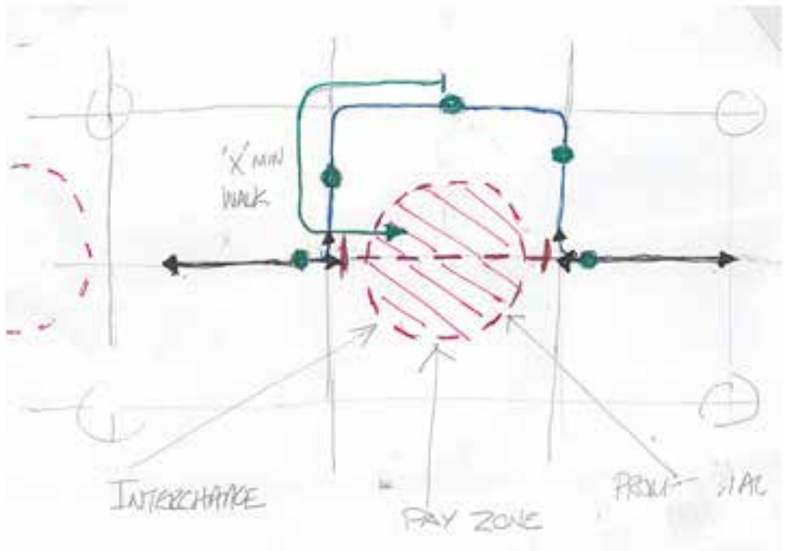
Anyone travelling to the station or the area in general by CAV will be dropped off outside the "drop-off zone", at a number of mini drop off zones surrounding the area. These drop-off zones will vary in fare depending on how congested the area is, and also how far they are from the final destination. The recommended drop-off zone for the user will also take into account their health, encouraging those who have not yet reached their daily steps to walk further to their final destination.

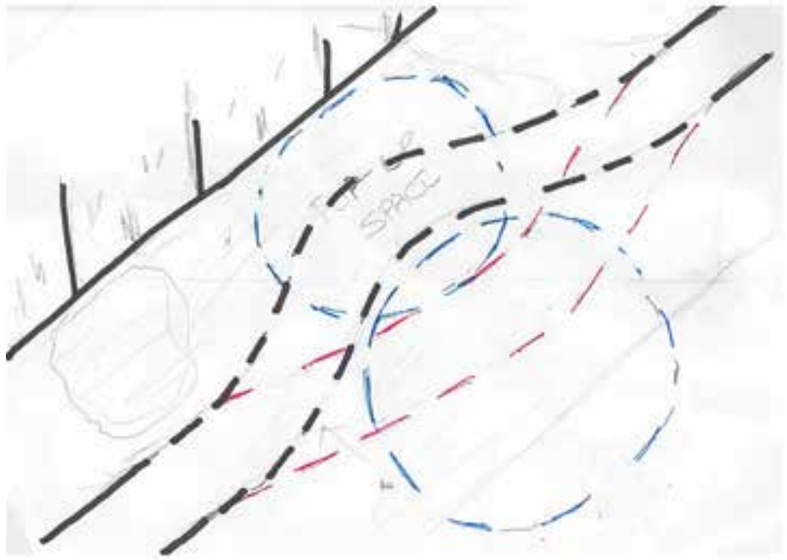
Why is this a good idea for your city?
We want Euston Station to become an international hub by 2030. As part of this vision we see a reduction in congestion outside the station becoming of paramount importance. This will help to create a wonderful user experience for anyone entering or exiting the Station.

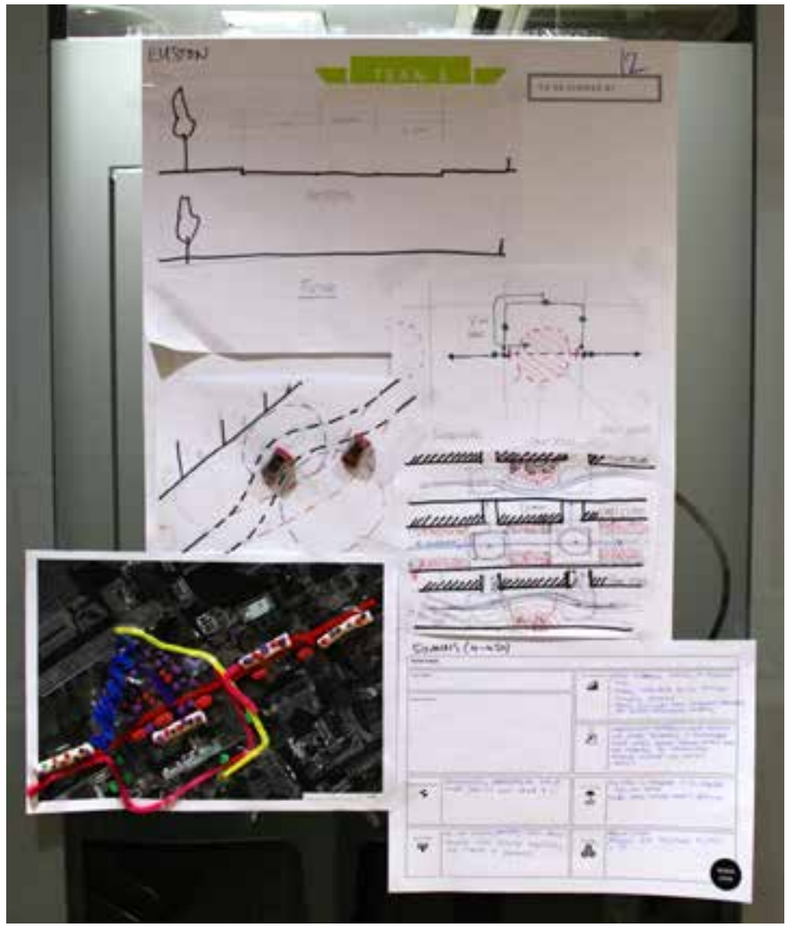
We also see our idea creating a wealth of economic and social benefit for the city, its residents and businesses. Our idea will attract businesses that want to hold events in public spaces that will contribute towards the local economy. It will also see the use of Euston Road dynamically changing providing a new level of excitement to its residents and visitors. Our idea puts control in the hands of the local authority, and ultimately in the hands of the people of London.

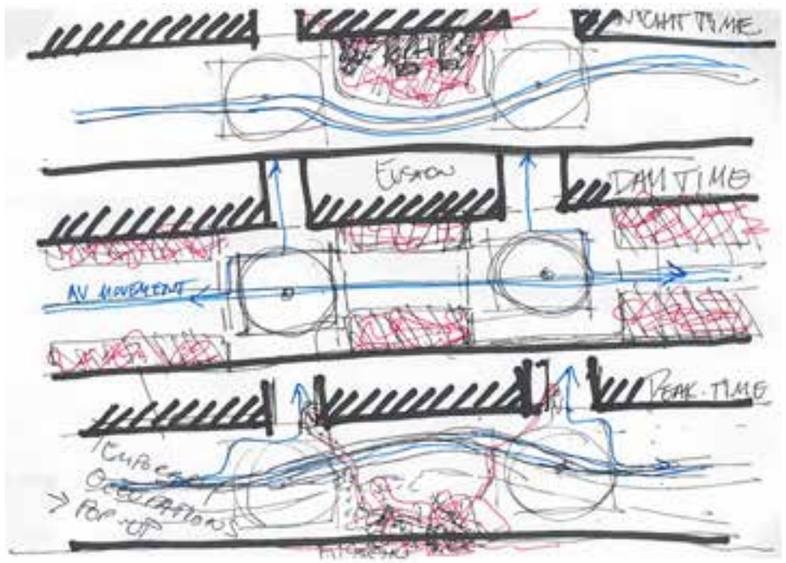
What would need to happen to implement your team's idea?
We see a potential first step in introducing "drop-off zones" outside the station. This could even be done before CAVs become a prevalent sight in London as it could work similar to the congestion zone. Within the zone, anyone could be charged for parking or dropping off inside the zone.
The London government could also start making more use of public areas and lease them out to local businesses for activities and events.

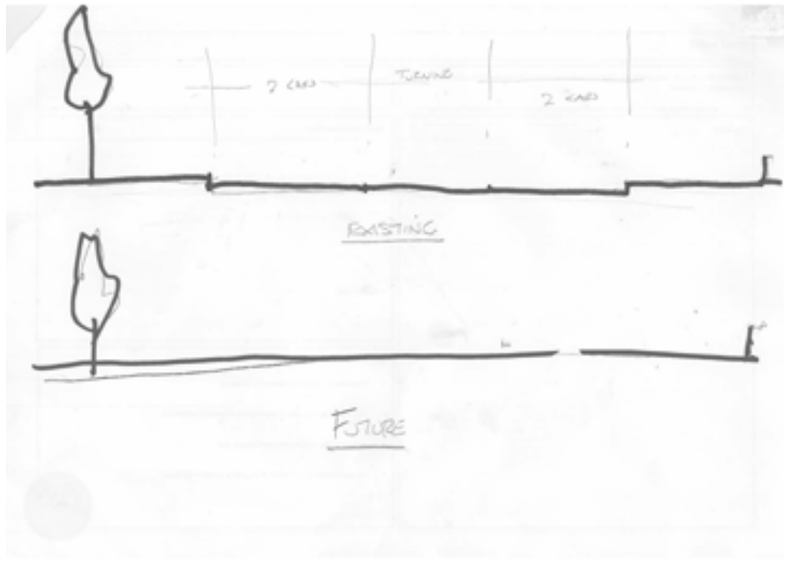
7.3 EUSTON ROAD - TEAM 1











7.4 EUSTON ROAD - TEAM 2

Andrew Comer (BuroHappold), **Averil Parlett** (City of London), **Mohamed Gaafar** (BuroHappold), **Nigel Bidwell** (Farrells), **Peter van Manen wwvccvv**(Living PlanIT)

Write-up by **Mohamed Gaafar**

What is your team's idea?
Our idea stems from harnessing the technology of CAVs and their potential space saving benefits, prioritising other road users to alter the current car-dominated paradigm, thus reclaiming and transforming roads into public spaces. On Euston Road and in central areas in London, there are huge opportunities to reclaim space by reducing the excessive number of single occupant cars driven and the cars parked. The occupancy level of cars on the roads is extremely important even with CAVs, because if people simply replace their cars with CAVs, it will also eventually lead to the same congestion and space problems.

We are hoping to change the views on car ownership by prioritising the preferred traffic to benefit the system as a whole. We will be providing a high-occupancy CAVs only lane, in order to discourage users from buying their own sole-occupancy CAV, they will either have to pay to use this lane if they are riding alone, or they will be forced to use the mixed-traffic lane. Vehicles that will be able to travel through freely would be CAVs utilising car sharing and car-pooling as well as autonomous taxis (sole-rider pods/ ride-share) and autonomous buses. Heave goods vehicles (HGVs) will only be able to make deliveries to Euston Road and the surrounding areas at night, to reduce congestion in peak hours.

In addition to imposing restriction of movement, we are imposing a restriction of on-street parking for all vehicles on the busiest roads in the borough; instead we are replacing these with drop off/pick-up zones for CAVs in selected areas. If these are high-occupancy CAVs, they will be able to park on quieter streets or utilise repurposed car parks, where they can park until required by their users. Autonomous taxis may idle on quieter streets until hailed by a new user; both sets of CAVs when not in use can plug in and provide capacitance for the grid.

These space savings will go to improving cycling facilities and pedestrian facilities along the road, and increasing the amount of public realm by reclaiming one lane of traffic and integrating more linear green spaces along the road. As our idea looks at the intermediate solution, the long-term vision is that as the adoption increases for high-occupancy CAVs, there should be an overall reduction in numbers of cars on the road and that the severity of the measures above can be increased, until only high-occupancy CAVs are allowed to enter such central zones. This would allow a much needed de-cluttering of the streets and the introduction of flexible and adaptable road/pavement and flow divider boundaries. Leading to a more shared-space style road, removing the need for kerbs (tactile paving provided) and crossings, Londoners already cross where they want to anyway!

Why is this a good idea for your city?
There are many advantages to the proposed solution, which include environmental, social and economic benefits. The environmental benefits are two-fold in terms of improving the environment of the public space and the wider environmental benefits. The improved use of space will be a huge benefit to the local users of Euston Road, and will produce an environment where pedestrians and cyclists will feel less marginalised. This will lead to improved uptake of walking and cycling in the local area in the long term; people will choose walking as it is more enjoyable.

The addition of green spaces and the ability to adapt the space for other purposes will allow the road to change function based on the time of day and will turn the road into a real social spot; i.e. at lunchtime, plenty of seating and road optimised for maximum pedestrians. Additionally, only allowing the movement of HGVs to occur during the night will also free up lots of road space, and help to more evenly distribute the spread of vehicles. Moreover, offsetting the harmful emissions to a time of day when there are less road users (though the goal is for greener HGVs in the future).

All the CAVs in the taxi fleets will be sustainably powered, either using electric, hydrogen fuel cell powered and where possible the electric chargers will be powered by solar/PV cells. In addition, the reduction of vehicles from the use of CAVs and the movement restrictions will improve the air quality and reduce the carbon footprint and noise pollution.

From a socio-economic viewpoint, there will be many advantages of changing public opinion on car ownership; people will no longer feel the need to own a car, when it is too expensive for them. Car sharing and car-pooling CAVs and autonomous taxis will become prevalent which has many economic advantages. As ownership models change, this means that more cars will be owned by the manufacturer or mobility service providers, who will be able to ensure (it is in their best interest after all) that a much more efficient car lifestyle occurs, with a better ability to reuse and recycle the car/car-parts.

What would need to happen to implement your team's idea?
As technology is always changing and improving, it is necessary that the policies governing these technologies must be as dynamic as possible. It is extremely important to find the right balance between policy and innovation such that the policy does not hold the technology back, except where necessary to ensure safety. This is particularly important with a safety-critical technology such as CAVs, especially as this innovation is expected to improve safety.

Policy will be required for the following:

- To restrict the movement of certain types of vehicles on Euston Road and in the surrounding central areas. It will need to be adaptable in order to encourage the right type of behaviour (i.e. car sharing, car-pooling and use of autonomous taxis) but also based on the level of adoption and the goals that have been set.

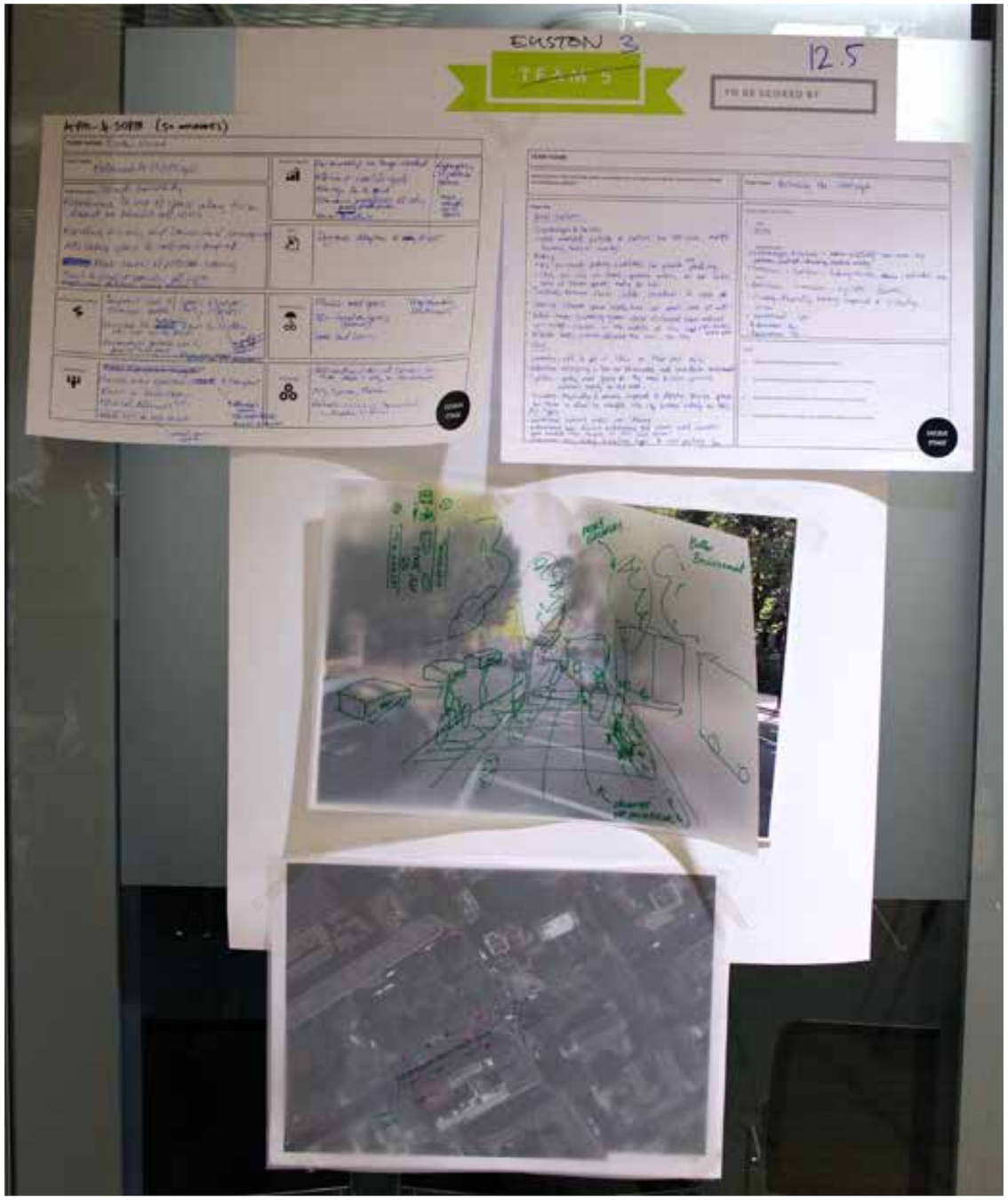
- To ban parking of certain types of vehicles on Euston Road and surrounding central areas.

- To restrict operational hours for HGVs travelling in central areas to only at night time.

In addition, the technology needed that is not currently in development, such as the adaptable road space ('programmable landscapes') needs to be developed, trialled and tested.

One of the biggest assumptions made, is that people will accept this shift in ownership model and be willing to change their behaviour based on the set of measures put in place. Thus, these changes will have to happen over a long period in order to change travel and ownership trends in favour of our solution.

7.4 EUSTON ROAD - TEAM 2



7.5 OLD STREET - TEAM 1

Lola Fernandez Redondo (Digital Greenwich), **Mehrnaz Ghojeh** (BuroHappold), **Nick Reed** (Transport Research Laboratory), **Richard Evans** (BuroHappold), **Tristan More** (Siemens)

Write-up by **Richard Evans**

What is your team's idea?
'Dynamic Is The New Old (Street)'. This proposal is aimed at transforming Old Street Roundabout by creating a vibrant, dynamic, user-driven flexible space. Set in the heart of East London's Tech City, the area is used by a variety of users throughout the day such as pedestrians, underground commuters, buses, leisure visitors and non-CA vehicles. The space is currently dominated by the gyratory, serving the needs of vehicular traffic whilst largely ignoring the needs of other users. 'Dynamic Is The New Old (Street)' proposes to remove the roundabout entirely, creating a flexible highway and public realm zone across the whole site with the junction configuration changing throughout the day, responding to different users.

To frame the proposal, the design year was set at 2030 when it is envisaged that all vehicles will be electric and form part of a city-wide Mobility as a Service (MaaS) offer and there will be a mixture of CAV and non-CAV traffic. It was also assumed that CAVs would result in a more efficient flow of traffic, even when mixed with non-CAVs, therefore making more efficient use of road space. With these parameters in mind, opportunities were found to transform the site to benefit all users, not just for those travelling by car.

Presently the infrastructure is fixed throughout the day, with no ability to adapt to changing profiles of users throughout the day. When traffic is less heavy such as during the interpeak and evening hours, the space still remains set-up for vehicles to the detriment of other users. This is considered wasted space which could instead be used to improve the vibrancy of the area. During times when traffic is less busy, some space previously traversed by vehicles may be opened to the community through the creation of a pop-up market, for example.

Four junction configurations have been proposed to cater for users at different times of the day.

- Commuters – i.e., 07:00-10:00 and 16:00-19:00: This configuration offers maximum movement to vehicles as well as pick up and drop off points for CAV users. Public realm adapted accordingly.

- Logistics – i.e., 10:00-13:00 and 04:00-07:00: This arrangement will give less movement to vehicles but create spaces for servicing to take place. Public realm opened up.

- Public Realm – i.e., 13:00-16:00 and 19:00-04:00: Spaces for community activities created, such as pop-up markets. Maximum public realm permeability.

- On-demand – i.e., 19:00-04:00: This arrangement caters for the night-time economy, where on-demand travel is important. Large provision of CAV pick-up and drop-off points as well as open public realm.

Why is this a good idea for your city?
It is believed that creating a vibrant, flexible space aimed at all users will improve the well-being and happiness of residents and other users alike, creating community cohesion, and increasing footfall and land values. As all vehicles are expected to be electric, this will have a positive impact on noise and air pollution.

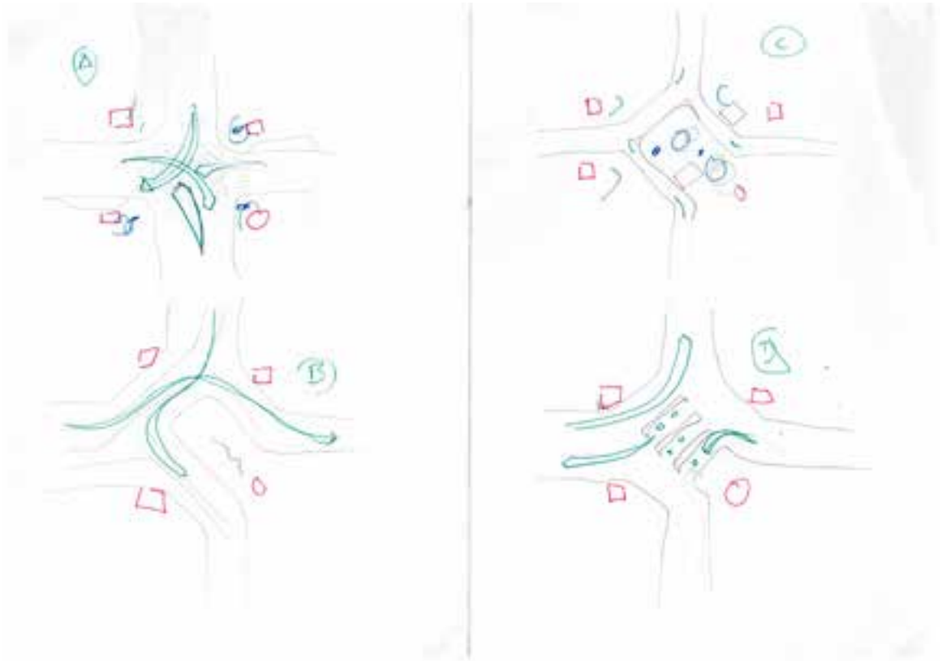
What would need to happen to implement your team's idea?
To implement the idea, a major infrastructure transformation is required. A shared-space type surface needs to be constructed with smart dynamic signage and road markings to respond to the dynamic road configurations, ensuring the space can be used by CAVs and non-CAVs safely. In the year 2030, we envisage local and national governments to be making efforts to integrate and encourage the use of CAVs, especially in a MaaS environment. To encourage take up in the Old Street area, it is proposed the roundabout becomes part of a dynamic road pricing area, with a charge applied to non-CAV vehicles at all times and increased during the peak hours. This will help regulate vehicle demand into the area over the day and encourage a more efficient use of road space.

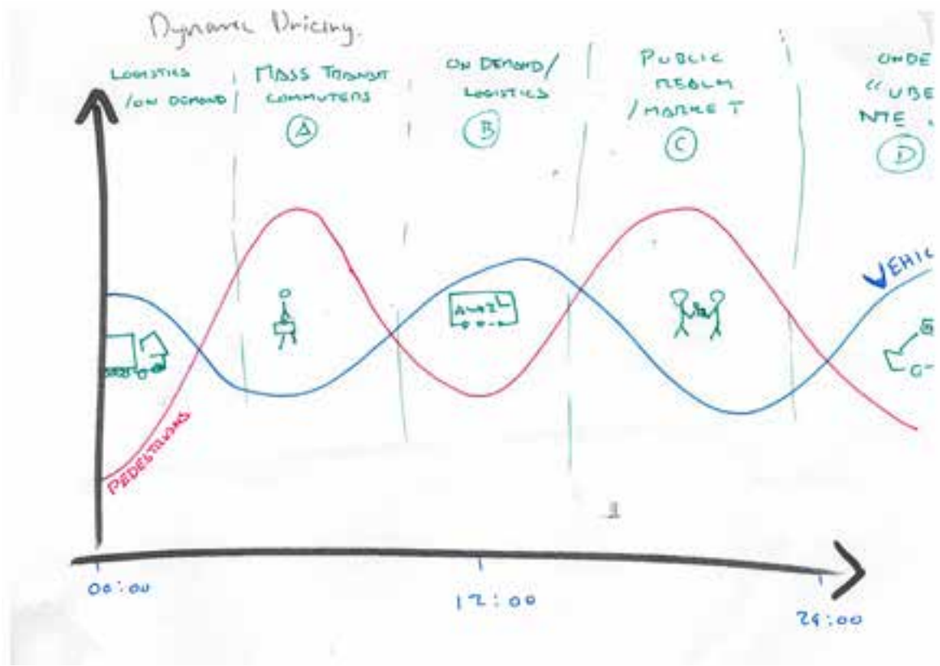
A key principle of the idea is for the users to 'own' the space by empowering the local authority to listen and respond to user feedback and requests. Regular consultations with user groups will be an essential part of this process.

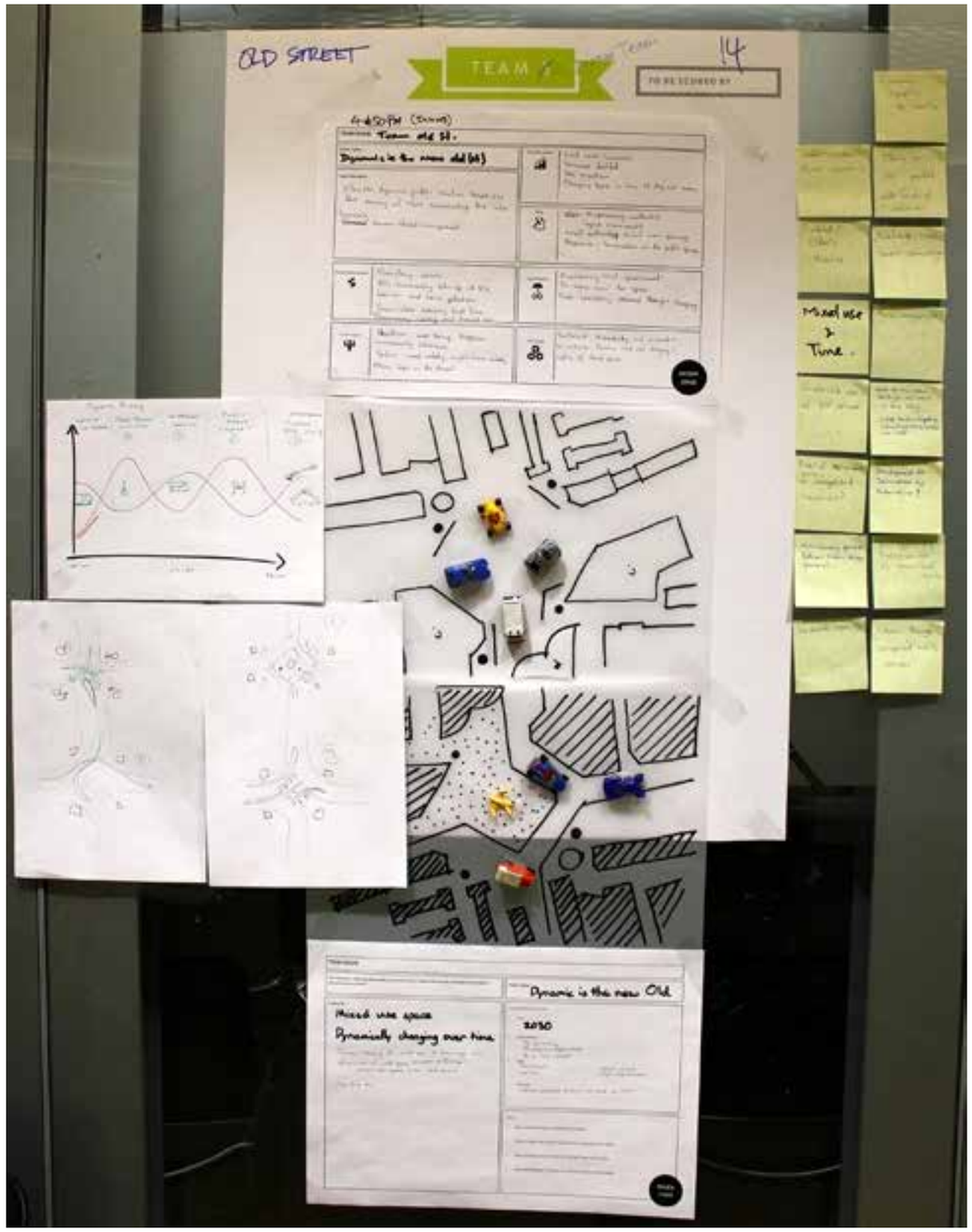
"Enjoyed that there were actually tasks that we needed to deliver so it focused us on certain topics. And I particularly enjoyed when we had to select, the team focused on developing ideas that we could then discuss and build on."

Mehrnaz Ghojeh
BuroHappold

7.5 OLD STREET - TEAM 1







7.6 OLD STREET - TEAM 2

Androniki Strongioglou (Gustafson Porter + Bowman), **Ben Goodwin** (Institute of Civil Engineers), **Dan Jackson** (BuroHappold), **Diane Lee** (Gensler), **Robert Moyser** (BuroHappold)

Write-up by **Robert Moyser**

What is your team's idea?
Our team developed a more enhanced roundabout design that aims at reducing the amount of space needed for the roundabout and increasing the space for park and ride. This will be done in a number of ways: Assuming a reduction of the number of cars on our streets, we reduce the number of lanes from 3 to 2 on the roundabout and approach lanes. We create a dedicated cycle lane connecting to a cycle route; and finally, we create a dedicated cycle lane on the approach lanes, which could also be used by CAVs but not by traditional cars (as we assumed a scenario date of 2030 where there would still be CAVs and normal vehicles on the road). With the remaining space, we will create a shared space to increase the size of the pedestrian realm.

Within the roundabout, we propose to take out the mechanical plant and open up the roundabout for use by commuters, for example, as a drop off and pick up area for CAVs and connection to a bike sharing facility. In addition, pop up retail and F+B will serve commuters. We assume that physically impaired travelers might want a safe route to the station so we left the underpasses in. We suggest using route-planning apps to help them navigate to entrance and exit locations. We assume that Mobility as a Service (MaaS) and joined up mobility cards would be commonplace to allow seamless and easy travel between modes.

Why is this a good idea for your city?
Old street roundabout is a classic highway intervention, with railings to direct pedestrians to safe crossings and a focus primarily on the car. Our solution focused on a more inclusive approach, acknowledging that the highway vehicle would still have a large role in this area but attempting a solution that recognized the growing trend to seamless safe travel between modes.

What would need to happen to implement your team's idea?
Obviously, policy written for CAVs and highway vehicles to inhabit the same space on the roads is a prerequisite. New regulations will spawn technical and performance specifications for the sensor technologies to support it.

Insurance policy will need to be upgraded to cover CAVs as well as the more humanistic rationale behind how a CAV has an accident and the choices the car might have to take to protect the life of travelers and wider public. This might need to be part of a standard option in terms and conditions that the driver has to sign prior to starting a journey. Alternatively, speed is limited to a max of 20mph in urban and 50mph in rural environments to ensure that response times are optimum whilst not compromising speed and travel times.

A lot of disparate traffic and transportation systems need to come together to deliver a connected MaaS solution. Therefore, a consistent data architecture will need to be deployed to ensure that new solutions can integrate with legacy.

Data security and privacy policy needs significant overhaul to ensure that CAVs are safe to use. For people causing mischief such as, for example, just walking in front of CAVs causing them to stop, policing will need to be directed to the causes of the incident and fines levied and/ or the human driver should have the ability to override the safety system to edge the car forward (just like one would do now).

7.6 OLD STREET - TEAM 2

KUALA LUMPUR : MARCH 2 2017

8. KUALA LUMPUR SPRINT

Kuala Lumpur (KL) is the centre of our work in South East Asia (SEA). Being the first Asian city where a Design Sprit takes place, it is an extremely interesting place to gather further insight on the global view of autonomous vehicles. South East Asia is home to over 600 million people, and whilst there are characteristics unique to each country, Kuala Lumpur can be considered as a good approximation to what challenges and opportunities CAVs would face in the region. Kuala Lumpur is the capital of Malaysia, home to a population of 2 million people, whilst Greater Kuala Lumpur has an approximate population of over 7 million people. It is a rapidly developing metropolis, with ever-increasing traffic challenges.

The Kuala Lumpur Design Sprint was organised in collaboration with Woods Bagot. The event was headlined by Damien Kerkhof, Director of BuroHappold in South East Asia and Matthew Gaal, Director of Development in SEA for Woods Bagot. The event was approximately 2-2.5 hours, allowing time both to introduce the topic and to develop designs for three distinct sites in KL.

Attendees for the workshop arrived from a large mix of stakeholders, representing local urban and transport planners, research organisations as well as governmental organisations overseeing urban development, public transport, road safety and introduction of new technologies in Kuala Lumpur and in the whole country. Participants engaged in very interesting and thought provoking discussions during the event highlighting their concerns and hopes with regards to CAVs. A number of questions and suggestions also emphasised the need to further our understanding of the topic to be able to fully understand the implications of this new technology.

Three main topics emerged during the initial discussions. The first one considered people and society. Several participants mentioned that since Malaysians place a large importance on car ownership as a status symbol, shared vehicles will probably not be highly regarded. As people are getting more affluent in the country, buying a car is still high on the priority list of families, who use it for daily commute as well as for family visits during the weekends and holidays. Making cars autonomous in this context would only change the driver, but would not necessarily achieve a reduced number on the roads. Questions of cyber security and individual trust in autonomous cars were also raised as concerns.

The second discussion topic was with regards to governance. It was unclear to the participants how the different government organisations should react to CAVs. It was suggested that they would be introduced into traffic or land use plans, however their special status will also have to feature in decisions about future infrastructure and especially public transport investments. Reducing car dependency and promoting public transport is part of the national strategy, where CAVs could play a role as last-mile service providers. However, this would generally only work if people accepted shared vehicles and non-private car ownership, something that looks controversial and unlikely today.

The third topic for which people expressed their views was about the actual physical implications of autonomous vehicles. Reduction of car parking and narrower car lanes quickly emerged as benefits, recognising that engineers will have to design for computer drivers rather than humans. A unique feature in KL and SEA in general is the importance of motorbikes as a transport option. CAVs will need to be prepared to coexist with passengers travelling by two wheeled vehicles, often not obeying traffic rules and waving their way through congested streets.

The broader discussions helped participants undertake the more specific task of reimagining three sites in Kuala Lumpur. Jalan Telawi III in Bangsar is a narrow two lane road, passing between a shopping centre and vibrant restaurant and shopfronts. Jalan Kiara links the Mon't Kiara township to the main highway, creating traffic congestion and an unsafe environment to children who attend the many schools in the area. Finally, the Bukit Bintang intersection is one of the main hubs of Kuala Lumpur, serving as a transport hub (MRT, Monorail, buses), as well as a busy tourist destination. Please find below the solutions our participants considered when reimagining these urban streetscapes.

KUALA LUMPUR : SITES

KUALA LUMPUR : WHY HAVE WE CHOSEN THESE SITES?

BANGSAR VILLAGE – TELAWI 3 STREET

Bangsar Village is a residential suburban neighbourhood as well as a vibrant entertainment and shopping area. Telawi 3 is one of the busiest streets, lined with bars and restaurants on one side and a shopping mall on the other. Heavy car traffic and parked cars on the road result in a dangerous and polluted environment.

BUKIT BINTANG – SULTAN ISMAIL INTERSECTION

The intersection is located in downtown Kuala Lumpur, surrounded by shopping centres, restaurants, hotels and a monorail stop, making it a prime tourist destination. Alleviating congestion and traffic pollution would help the neighbourhood to develop to its full potential.

MONT KIARA – JALAN KIARA

Mont Kiara is one of the many mixed use township areas in Kuala Lumpur. It has residences as well as offices and educational facilities. Its use patterns result in high congestion during peak hours, with commuters moving in and out of the development through its access roads. Improving its connections and internal traffic will be important to ensure high quality of life for its residents.

8.1 JALAN TELWAI 3, BANGSAR

Damien Kerkhof (BuroHappold), **Vera Fonseca** (Woods Bagot), **Muhammad Ruhaizat Abd Ghani** (MIROS), **Ir. Ong Sheng How** (Atur Trafik Sdn Bhd), **Norliza Hashim** (APUDG), **Faqroul Hafeez Saipuddin** (SPAD), **Norsam Tasli Mohd Razali** (MIGHT), **Ngeow Zoo Gin** (Autolive Hirotako)

Write-up by **Vera Fonseca**

Bangsar Village is a residential suburban neighbourhood as well as a vibrant entertainment and shopping area. Telawi 3 is one of the busiest streets, lined with bars and restaurants on one side and a shopping mall on the other. Heavy car traffic and parked cars on the road result in a dangerous and polluted environment.

What is your team's idea?
In a city with very limited street life, due to the imposing presence of transport vehicles and the lack of city planning, maintenance and regulations, we would like to use the CAVs as the catalyst for urban regeneration in Kuala Lumpur. Our idea, simply put, is to create more and more diverse public space.

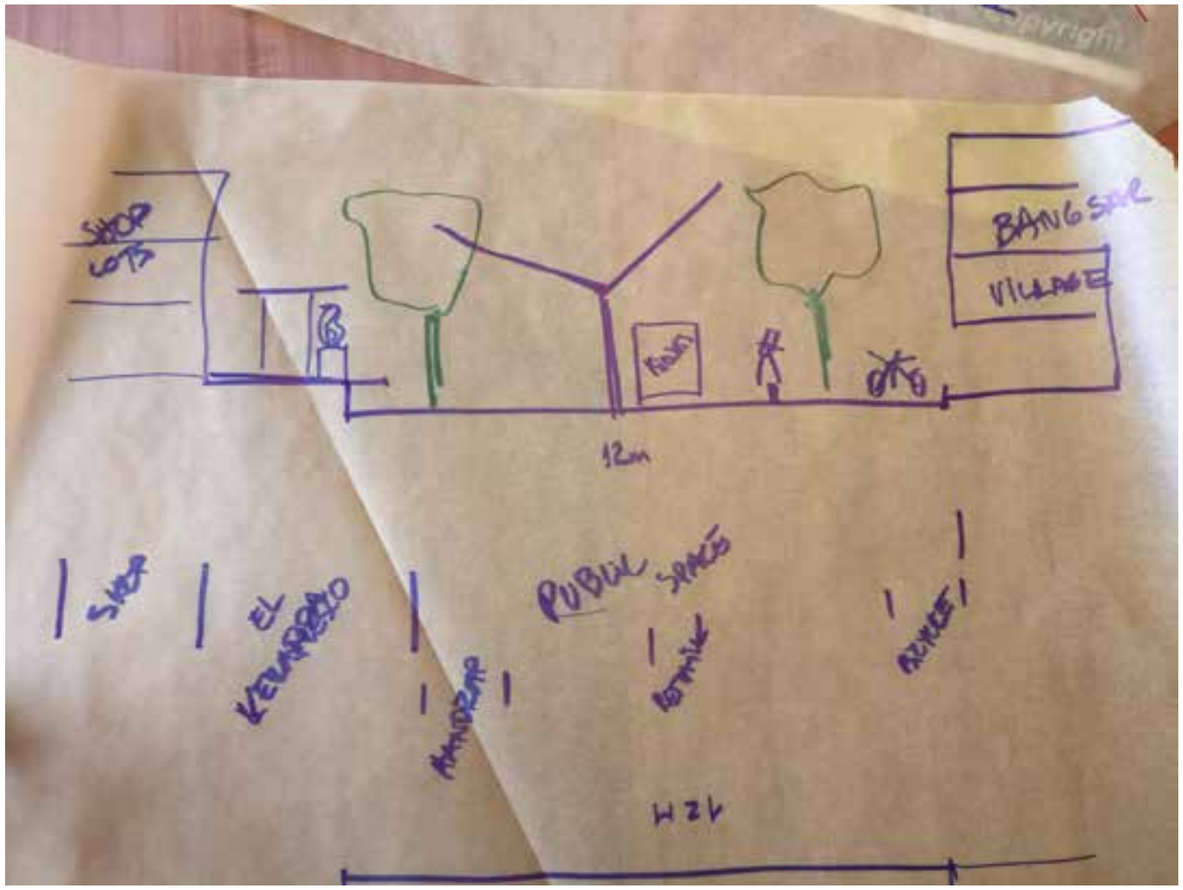
Why is this a good idea for your city?
Kuala Lumpur has a climate that traditionally limits street life. Due to heat and humidity, residents prefer transportation that is closed from the elements, primarily cars. Today the city is filled beyond its capacity with cars as well as other modes like motorcycles, monorails, and metro lines. More and more, pedestrians are pushed away from the streets into the interior of privately owned mega constructions; malls. The privileged domain for the urban encounter has shifted and consequently so has urban life. Urban street features are rare and so are open spaces or parks where people could relax and engage with each other. Meanwhile, the need is clearly there, as people much appreciate any attempts of creating such an environment, actively seeking new pop ups of food stalls and street fairs (pasar malam). It is therefore important to look at how it is possible to upgrade the urban environment, especially in low rise residential / retail areas.

What would need to happen to implement your team's solution?
The way to go forward is to re-establish hierarchies in the urban fabric. By returning the street to the pedestrian, and limiting the access of vehicles, we hope to instigate the use of the leftover space for the regeneration of the urban life. We do not believe in completely removing transportation from all areas of the city, but we do believe that with the implementation of CAVs we would be able to reduce pollution, improve road safety, and take some of the areas currently assigned to vehicles and give them back to pedestrians. We would like to think that by reducing the amount of carparks and roads, we will be able to improve walkability around the Bangsar area. This will help to create a sense of community by readjusting the primary place of urban encounters back into the public realm, facilitated through the creation of squares, parks, recreational points for children, elderly and families with the ultimate goal of promoting a higher quality of life to the citizens of Kuala Lumpur.

"Most importantly, we can try to have lots of public spaces, to let Bangsar transform into a people's place."

Norliza Hashim
Managing Director, AJM Planning and Urban Design Group

8.1 JALAN TELWAI 3, BANGSAR



8.2 JALAN BUKIT BINGTANG

John Gregson (BuroHappold), **Herkrishan Sohal** (Woods Bagot), **Justina Chen** (Future Cities), **Mohd Shahril Kaider** (Atur Trafik Sdn Bhd), **Soondoos Zahry** (APUDG), **Steven Tan Kim Bock** (Dewan Bandaraya Kuala Lumpur), **Lee Chong Jin** (Autolive Hirotako), **Lawrence Liew** (ITS Malaysia).

Write-up by **John Gregson**

Jalan Bukit Bintang (JBB) / Jalan Sultan Ismail (JSI) intersection is located at the heart of Kuala Lumpur's city centre, surrounded by a cluster of retail shopping malls, food and beverage outlets along with hotel and office space. Outlets range from high-end malls to low-cost street stores.

One-way traffic flow operates from east to west along JBB, and from south to north along JSI. Key public transport links are the adjacent Monorail station on JSI, and a new underground Metro station with pedestrian access from all four corners of this intersection (due to open mid-2017).

A year 2050 scenario was used, with CAVs considered to comprise a majority of the KL vehicle fleet. Further densification would likely occur when surrounding plots are redeveloped, increasing daily population.

What is your team's idea?
A balanced solution was developed that recognises the various modal and user demands of this key city hub, and impacts to surrounding streets:

- Pedestrianise JBB (east-west), shifting traffic to arterials to the north or south around the centre, removing four lanes of traffic.
- Remove the current elevated monorail from JSI median and replace with CAV public transport buses along the corridor.
- Restrict JSI to fully autonomous vehicles only.
- Convert JSI from one-way to bi-directional traffic flow – CAVs would optimise traffic flow during peak periods.
- Reduced JSI road space (from five to three lanes, with narrower lane width) to increase pedestrian space.
- Provide lay-bys either side of JSI for pick-up and drop-off, with illegal parking on footpaths regulated.
- Managed pedestrian crossing points to reduce conflict with CAVs.
- CAV service delivery, managed within off-peak hours.

Why is this a good idea for your city?
Pedestrianisation of JBB and improvements along JSI would benefit shoppers, traders and tourists who use this area. Opportunities exist with reduced road space to green the streets and improve microclimate in a hot tropical environment, and to integrate street vendors and markets, common in suburban areas, into the tourist centre.

Opening of the new rapid transit Metro line and station in 2017 could stimulate transit-oriented development, supported by CAV bus routes along JSI. CAV buses would likely be cheaper to operate than an ageing Monorail system (an option to convert the elevated Monorail to a pedestrian route a-la the NY High Line exists).

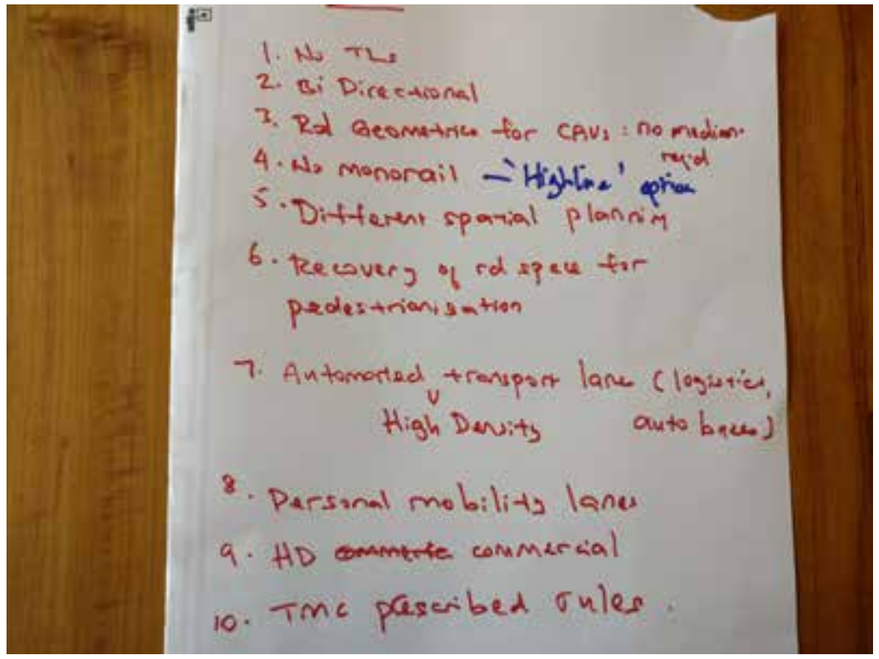
Restriction of non-CAV vehicles from the centre may incentivise CAV uptake, and it permits bi-directional use of JSI, providing more efficient navigation of the city centre compared with KLs notorious one-way road networks.

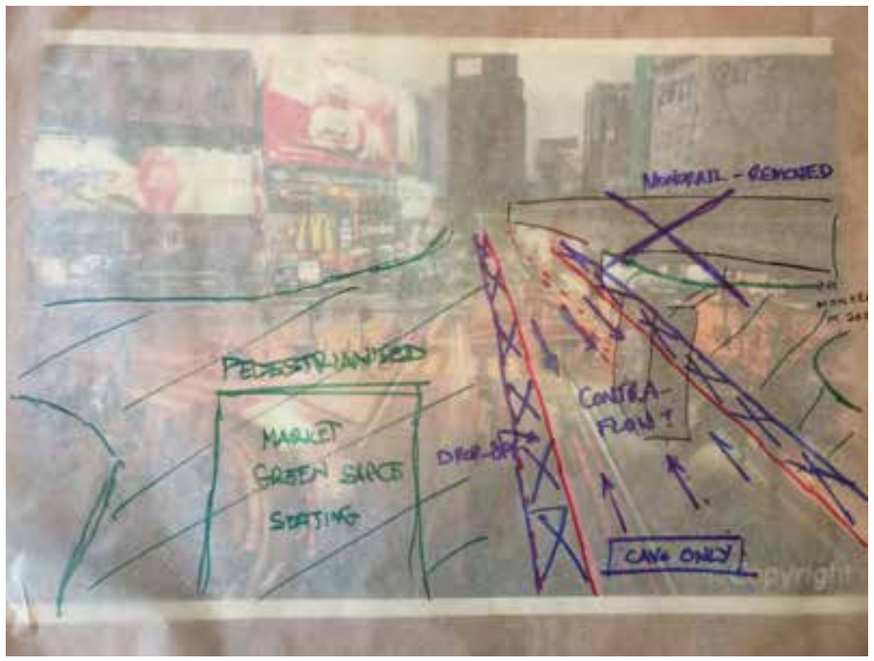
What would need to happen to implement your team's solution?
Implementation requires some reconfiguration of the surrounding street network and traffic flows to support closure of JBB, while restriction of JSI to fully autonomous vehicles only is required to achieve bi-directional and efficient flow along JSI.

Prior to that, road space could be gradually reduced in line with increasing transit ridership servicing the area, along with enforcement of gradual traffic restrictions in the central area such as to certain vehicles (CAVs, taxis) or certain times (shopping peak periods).

> *"The density, population, land use will all likely change, increasing the number of pedestrians in the area."*
>
> **John Gregson**
> Senior Consultant, BuroHappold

8.2 JALAN BUKIT BINGTANG





8.3 JALAN KIARA, MON'T KIARA

Lee Siew Ngah (BuroHappold), **Matthew Gaal** (Woods Bagot), **Chin Kar Keong** (REAM), **Noraida Saludin** (APUDG), **Zulkarnain Hamzah** (SPAD), **Azmil Mohd Amin** (MIGHT), **Hizal Hanis Hashim** (MIROS).

Write-up by **Siew Ngah Lee**

Jalan Kiara is the main collector road from the inner residential suburbs of Mon't Kiara to the arterial SPRINT Expressway connecting the township to Kepong and Kuala Lumpur city centre. The bi-directional two-lane road serves the residential communities and commercial complexes in the area. As at present, the road is heavily congested especially during peaks hours with two operational schools in the area and with most commuters resorting to using own transport modes as seamless public transport accessibility is few and far in between.

The scenario of 2050 has been envisioned where the suburb of Mon't Kiara will fully embrace the use of autonomous vehicles. Private vehicle usage is expected to be still largely predominant as the population grew in size over the years with Mon't Kiara serving as the choice residential district for working professionals in central Kuala Lumpur.

What is your team's idea?
Admittedly the number of traffic lanes shall be increased with future population growth. The increase is made possible considering autonomous vehicles will behave systematically in a single file as opposed to unpredictable humans' driving behaviour. Protected motorcycle lanes are to be provided for a safe integration of autonomous vehicles with the popular two-wheel vehicle on a shared space. This would also require a re-synchronisation of traffic light with the CAVs' system and signalised pedestrian crossing. In supporting an autonomous community, connectivity and traffic circulation within the locality is also equally important; therefore, the local network has to be connected to the wider external network. Naturally, the volume of pick-ups and drop-offs will also build up, requiring more conducive drop-off locations to be identified for looping traffic to circulate seamlessly. The traffic will be converted into a one-way directional traffic without allocating any space for on-street parking. Existing parking lots at adjacent developments shall be re-defined and converted into CAVs hub for the autonomous vehicles to recharge; available to the general public. Priority access to Jalan Kiara and surrounding localised network shall be given to CAVs, assuming other standard vehicle modes are still being used in other Kuala Lumpur suburbs.

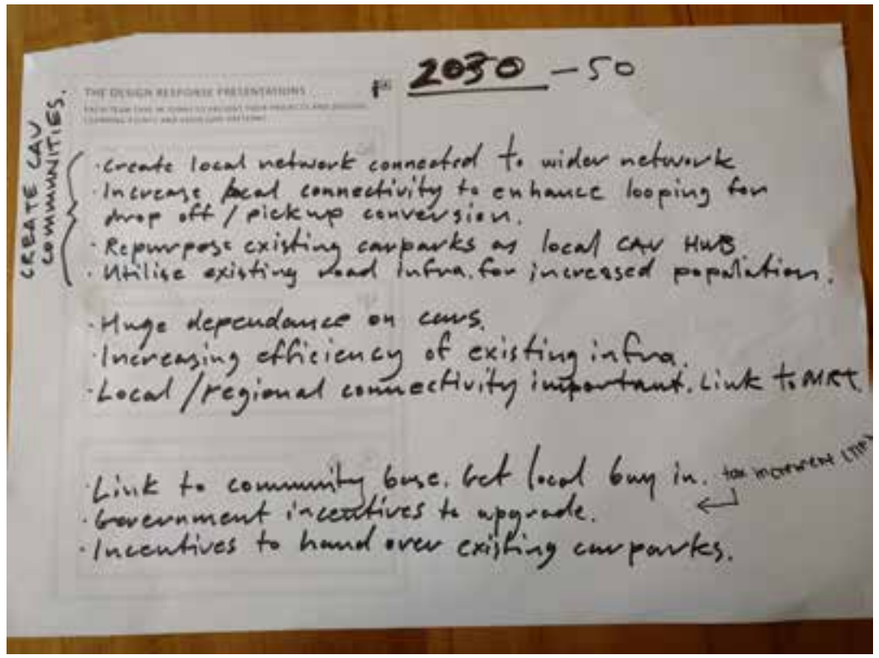
Why is this a good idea for your city?
Kuala Lumpur has been a society with a long history of having huge dependency on private vehicles and thus shall greatly benefit from the shared use of autonomous vehicles. The transformation of the urban planning design brought about by the introduction of autonomous vehicles shall also increase the efficiency of existing road infrastructure. By 2050, Malaysia would have been a country of aging population, therefore, autonomous vehicles will provide a means of mobility to individuals deemed unsuitable to manually drive by then. Autonomous vehicles could also be the link acting as feeder to the MRT, the nearest being the Pusat Bandar Damansara station. With the hugely exorbitant land price in Mon't Kiara, the re-purposing of existing car parks into retail areas can generate more revenue for developments as the parking lots would no longer be in large demand.

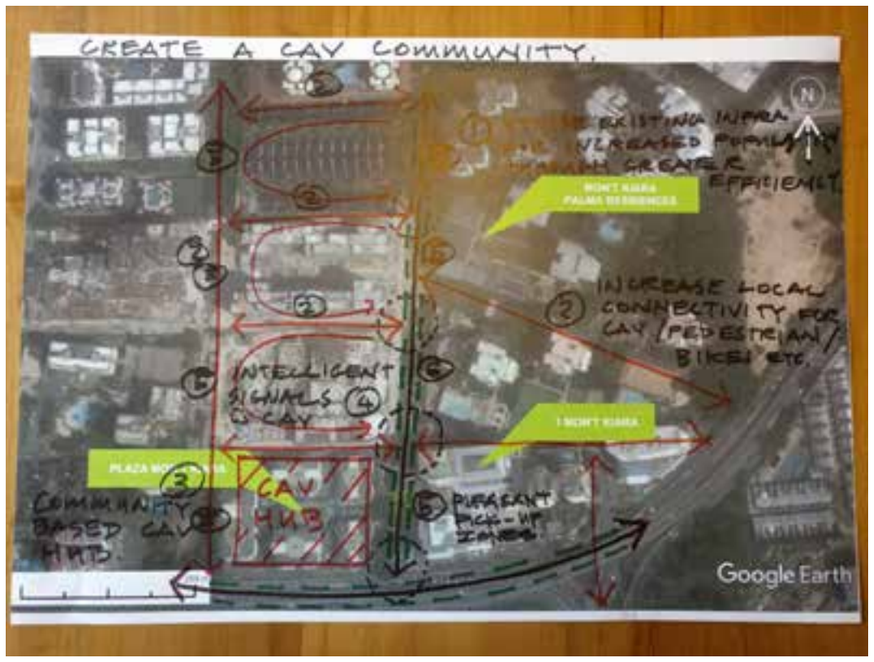
What would need to happen to implement your team's solution?
Implementation could be promoted in an area of strong community base such as Mon't Kiara with local participation. Strategies could include tax increment financing to support developers to re-define surrounding development to be a CAV friendly zone. Developers should also be made aware of the benefits of handing over existing parking lots for re-generation of the development. Other government incentives could be used to assist the general public to upgrade to CAVs from standard vehicles.

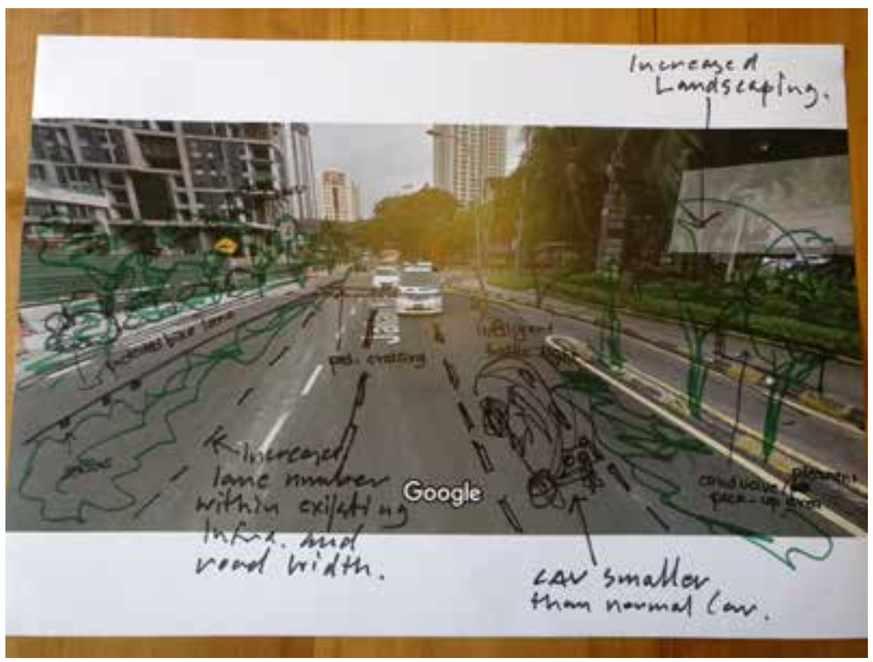
"Our idea is to create a CAV community in Mon't Kiara."

Ir. Kar Keong Chin
Managing Director, Road Engineering Association of Malaysia

8.3 JALAN KIARA, MON'T KIARA







NEW YORK : MAY 16 2017

9. NEW YORK SPRINT

New York is probably one of the hardest nuts to crack for CAV technology – the density and complexity of street life could bring autonomous vehicle traffic to a standstill. At the same time, Mayor Bill de Blasio's administration is working hard towards Vision Zero – ending traffic deaths and injuries on New York City's streets. CAV might eventually help achieve this goal, but in the meantime, there are concerns that a transition phase could also increase traffic accidents. To better understand the potential of new technologies in the management of New York's transport system, the NYC Department of Transportation is participating in a federally funded Connected Vehicle Pilot program. Hosting a Design Sprint in New York City was therefore intriguing from the very beginning of the initiative.

When we spoke with individuals at URBAN-X, a new venture accelerator backed by MINI that educates, invests in, and advocates for startups shaping the future of cities through technology and design, they immediately liked the idea of hosting a Design Sprint in their refurbished premises in Greenpoint. There was high demand from participants to attend the Sprint and we wanted to tap into the rich expertise that is located in New York City. We thus ended up organizing our largest Design Sprint with forty participants from local and state government agencies, utilities, planning and design firms, car companies, and research institutes.

After Micah Kotch from URBAN-X welcomed the Sprint attendees, Rodney Stiles, Assistant Commissioner for Data & Technology at NYC Taxi and Limousine Commission provided some background on New York City's initiatives related to connected and autonomous vehicles. Participants started working on reimagining specific sites in New York City for an era of autonomous and connected vehicles. We selected four sites: the Port Authority Bus Terminal, a major transportation hub for New York City; a typical low-rise mixed-use and residential block in the East Village; Columbus Circle at the south-west corner of Central Park; and McGuinness Boulevard in Greenpoint. Each of the sites had its own challenge – from integrating a commuter transport hub (Port Authority) into the local transport network to calming a busy residential street (East Village); from managing deliveries in a commercial area while creating an attractive tourist plaza (Columbus Circle) to knitting together the industrial and residential parts of a neighborhood (Greenpoint).

The NYC Design Sprint showed that New Yorkers are keen to reverse the prioritization of individual car usage over pedestrians and cyclists and giving the latter more space in today's urban environment. There was talk of removing onstreet parking, road-diets, and sidewalk widening to increase space for non-motorized modes of transportation or even using new technologies to dynamically close streets that today are reserved for cars for kids to play. Another central point was the need for space to serve an ever increasing delivery economy. Again, today's onstreet parking was seen as an option to create drop-off and pick-up lanes for delivery vehicles. Finally, the discouragement of single-occupancy vehicles was promoted – through improving the commuting system by modular buses that can connect to trains or policies such as dynamic pricing. It remains to be seen what can be achieved in the political context of New York City, but the advent of connected and autonomous vehicles might create the necessary pressure to move some of these policies, most of which are already applicable today, forward.

NEW YORK : SITES

NEW YORK : WHY HAVE WE CHOSEN THESE SITES?

10TH STREET & AVENUE A

The corner of 10th Street and Avenue A is located in the East Village, a residential neighborhood with active streets of cafes, shops, and restaurants. The intersection is at the north-west corner of Tompkins Square Park, a key public space for the neighborhood. It's also a key cycle rout for the east/west crossing of Manhattan and has an express bus lane going north/south. In a future of connected and automated vehicles, how will these different modes interact with each other?

PORT AUTHORITY

The Port Authority Bus Terminal, on 41st Street between 8th and 9th Avenue, is the busiest bus terminal in the US, serving 8,000 buses and 225,000 people on an average weekday. The terminal has reached capacity during peak hours and there are several other issues to be solved. Will a mobility hub like this still exist in an age of connected and autonomous vehicles and if so, how will it interact with the surrounding avenues and streets? Do we need to rethink the integration of different modes and create better pick-up and drop-off zones?

GREENPOINT

Greenpoint is an up and coming neighborhood that is undergoing a major transformation from an industrial district towards a mixed-use neighborhood with creative professionals, tech companies, and residential buildings. McGuiness Boulevard is its main throughfare leading up to the Pulaski Bridge. It also happened to be the neighborhood where the Design Sprint took place. How will a neighborhood with relatively limited access to transit be impact by connected and autonomous vehicles?

COLUMBUS CIRCLE

Columbus Circle is a bustling traffic roundabout with four lanes. At the center of the roundabout is a public square with a monument of Columbus. It is in a typical mixed-use neighborhood of upper Manhattan with lots of retail, office buildings, and residential towers. Moreover, it is at the southeast corner of one of New York best-known public spaces: Central Park. Could this space be re-thought as a more pedestrian friendly entrance to the park? And how might we reconsider roundabouts in an era of connected and autonomous vehicles?

9.1 10TH STREET & AVENUE A 1

Anthony Townsend (Bits and Atoms), **Ariella Maron** (BuroHappold), **Ben Mandel** (City of New York, MOS), **Julia D Day** (Gehl Studio), **Kate Burson** (Tesla)

Write-up by **Ariella Maron**

What is your team's idea?
10th Street and Avenue A in the East Village is surrounded by a mostly residential area with ground floor retail and Tomkins Square Park. The intersection and the park create a gateway from the transit desert of Alphabet City to the east and the transit-rich Village. In the evening and weekends, this area becomes crowded and congested with taxis dropping off and picking up visitors to the area's restaurants and bars and families enjoying the park and other urban amenities. This congestion results in both noise and air pollution as well as poses safety threats for pedestrians, impacting the quality of life in what otherwise could be a quiet, residential neighborhood. 10th Street and Avenue A provide access to the park, retail, and nearby transit; both streets are two-way and include critical bus routes, bike lanes, and on-street parking. There is a lot of competition for space on the street, contributing to the congestion and impeding bike use, access to the park, and efficient commutes. For these reasons, the team felt its top objectives were to come up with ideas to:

01. improve quality of life and sense of place by addressing noise, emissions, convenience, and other congestion related issues;
02. discourage single-occupancy vehicles, while allowing people and goods to move more efficiently into and out of the area;
03. make walking, biking, and shared transportation the preferred modes of transportation by making them safer, more pleasant, and more efficient; and
04. enhance access to the park by making the park more porous and addressing the barriers that 10th Street and Avenue A pose.

The team developed a pilot program* that included a number of interconnected policy and design interventions to test whether they could achieve these objectives. The team realized that these objectives could be met without CAVs; however, the introduction of CAV technologies – integrated into shared vehicles, buses, bikes – would allow for the implementation of these interventions to occur more efficiently.

* assumes vehicle and pedestrian flows as well as public life and space are analysed ahead of time.

The policies for the pilot area included:

- Prohibit on-street parking
- Allocate curbside space as drop off zones for deliveries and people to eliminate double-parking; a major source of congestion. The allocated space regulations will follow time-of-day rules, meaning they may change throughout the day to best accommodate delivery times and commuting needs. If it is found that congestion along the curbside is still expected from drop offs, then a pricing scheme will be put into place (a la surge pricing on Uber)
- Enlarge and locate the active transportation areas (pedestrian areas, bike lanes) closest to the park
- Only allow shared vehicles (shared cars, buses, etc.) and delivery vehicles on these two streets; in the long-run, these vehicles will all be shared CAVs (cars, shuttles, buses) and delivery vehicles.

The design interventions for the pilot area included:

- Make both 10th Street and Avenue A one-way streets with specific spaces allocated for pedestrians, cycling (own lane); shared vehicles (own lane), and loading/unloading.
- Make a close parallel street (i.e., Avenue B and 11th Street) one-way the opposite direction
- On Avenue A, in order from the park:
  - widen pedestrian areas to allow the park to overflow
  - install larger and improved bike lanes, located closest to the park
  - allocate space for shared vehicles
  - allocate space for people and goods drop-off
- On 10th Street, in order from the park:
  - improve bike lane infrastructure
  - limit driving lane to shared vehicles (no personal vehicles)
  - allocate more limited space for deliveries; focused on the corner

Why is this a good idea for your city?
This pilot program allows for testing the ability of CAV technologies and related policies and design to help pedestrianize NYC's neighborhoods, improving health, safety, and quality of life. It encourages the use of more active modes of transportation by making them safer and more pleasant and addresses curbside congestion related to increase in personal deliveries (e.g., Amazon, Fresh Direct, etc.). Finally, it enhances access to open space like the Tompkins Square Park.

What would need to happen to implement your team's solution?
The following tasks would need to be undertaken to create the pilot program:

- A vehicle and pedestrian flow study of the neighborhood as well as an analysis of how people currently enter, exit, and use the park
- Department of Transportation (DOT) approval to prohibit on-street parking and allow for space to be allocated for deliveries. If pricing is included, a pricing model will have to be created
- City infrastructure that can communicate to CAVs on where they can drive, where they can drop off things, and possibly how much it will cost. Eventually, the City will be able to remove related signage
- Removal of fence along park, adjacent to these streets
- Capital investment to improve bike lanes
- Installment of a temporary barrier to keep non-shared vehicles from entering the pilot area

9.1 10TH STREET & AVENUE A 1

9.2 10TH STREET & AVENUE A 2

Ari Kahn (ConEd), **Daniel Pittman** (A/D/O), **Josh Margul** (BuroHappold), **Lauren Baird** (OMA), **Mobeen Bhatti** (NY Governor's Office)

Write-up by **Josh Margul**

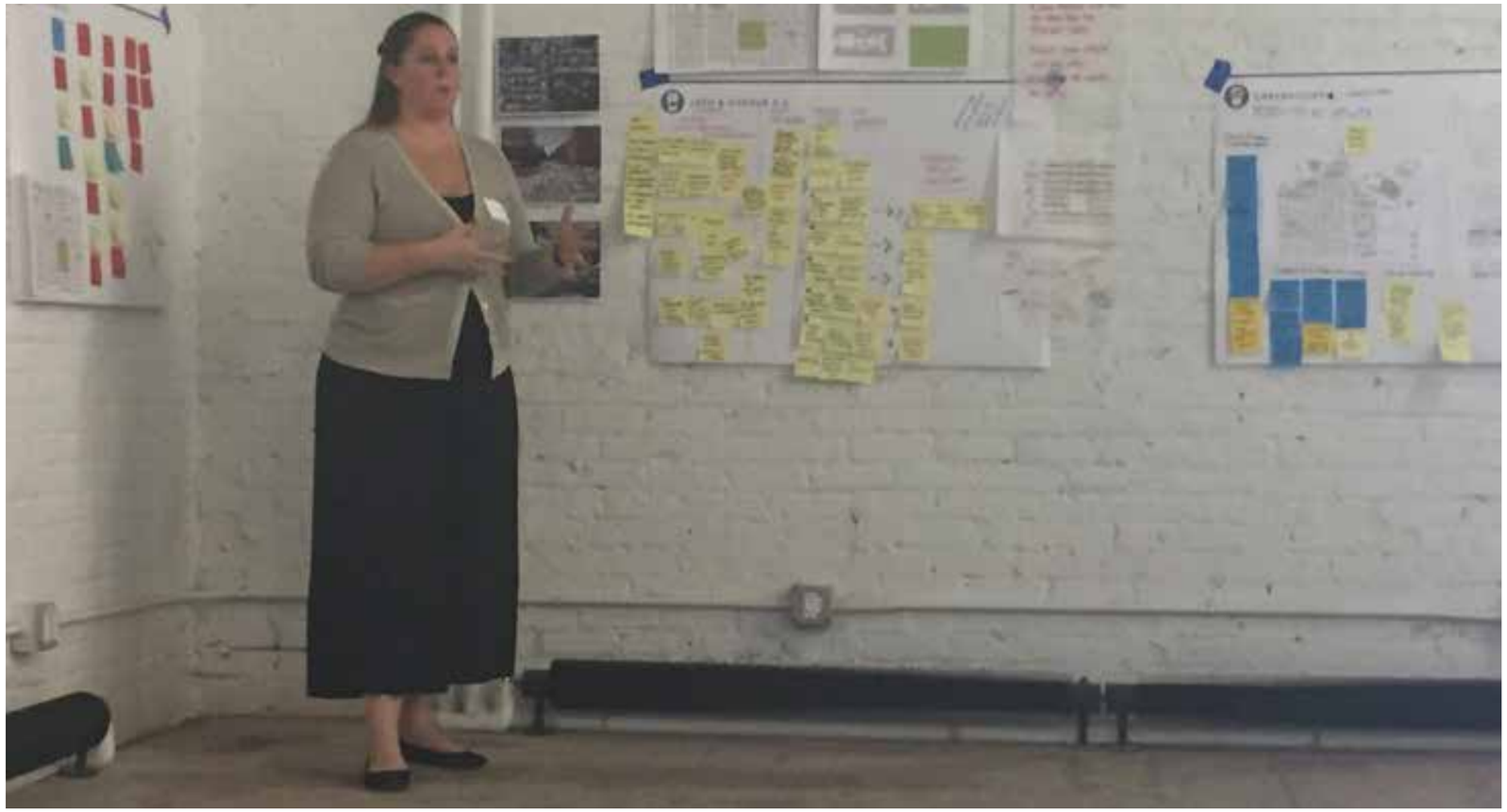
What is your team's idea?
Our team's first step was to frame the neighborhood by its different users, their needs, and the temporal qualities (day vs. night, weekday vs. weekend). This portion of the neighborhood is not in the heart of the most intense restaurant and nightlife area of the East Village, but it still gets spill-over. It is primarily residential with limited amounts of residential-serving retail along Avenue A. Weekday mornings see mostly one-directional movement of a mass of people north to 1st Avenue or west to Union Square/Astor Place stations. Throughout the rest of the day, it is mostly quiet. There is a Sunday greenmarket along Tomkins Square Park. With that framing, different "users" were determined, each with a district transport-related problem and a different spatial need:

"User"	*Problem*	*Spatial Need*
Daily commuters	How to move large crowds to Union Square, the nearest hub	Wider sidewalks and bike lanes for pedestrian power, dedicated lane for AV shuttle of some form
Elderly and disabled	Taxi replacement	Safe drop-off location
Weekend families / market visitors	Taxi replacement	Safe drop-off location
On-demand freight delivery for residents (e.g., Amazon)	How to facilitate increasing deliveries to dense residential area	Drop off location on every block or mid-block

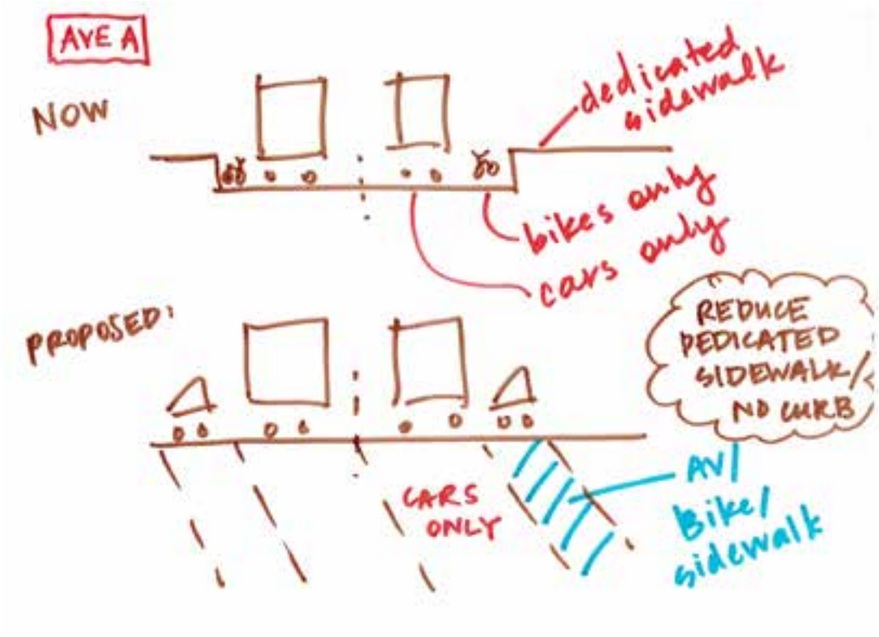
The team decided to look at a 5-10 year horizon, for intermediary/ transitional improvements to a CAV-rich environment. The design solution to address the spatial needs of this area were to create "shared (with CAV) streets)" every three or so blocks which allow CAVs, pedestrians, and bicycles, but no traditional vehicles. The "standard" streets would have parking removed from both sides (as overall demand will drop), with this space reallocated for CAVs and bicycles on one side, and for pedestrians (sidewalk expansion) on the other.

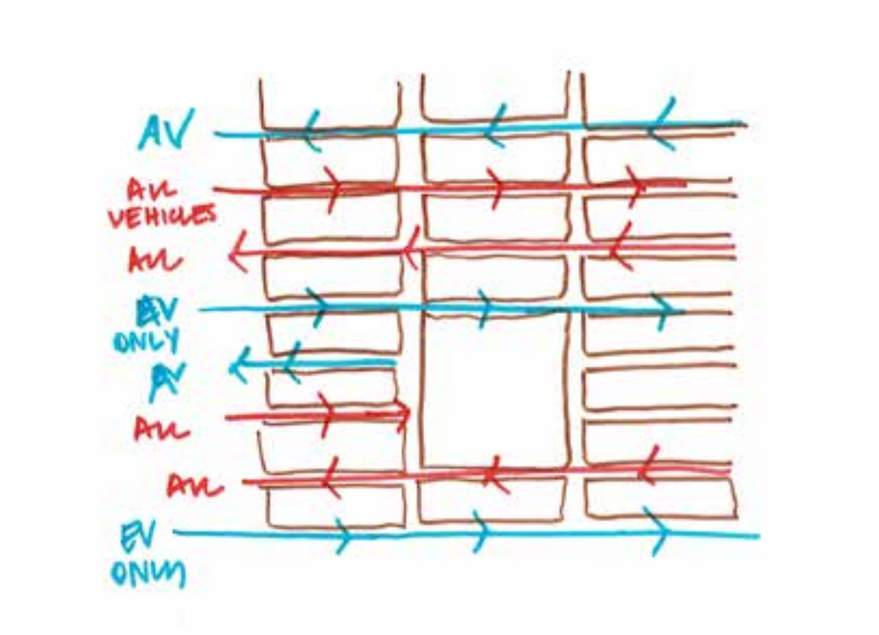
Why is this a good idea for your city?
This area of the East Village is far enough away from the heart of the commercial activity to not be overly congested at present, and Tompkins Square Park serves as a (useful) barrier to vehicles attempting to pass through the neighborhood. It is otherwise a "standard grid" area of the city, with generally rational and predictable pedestrian flows at different times of the day/days of the week. In other words, it is remarkably typical. We spend most of our time in and around our homes/neighborhoods, and in thinking about how CAVs will operate in the city of the future, we should not sideline these areas in favor of focusing on high-traffic commercial areas. This area of the East Village could serve as a potential pilot/proving ground for how CAVs could work in a primarily residential neighborhood on a grid.

What would need to happen to implement your team's solution?
Autonomous vehicles are strictly regulated by the state government, and were only made legal as of a week before the NYC Design Sprint. Approvals are required of routes and technology. This permits some of our needs (a CAV bus solution for commuters to train stations), but not most of them (taxi replacement and goods delivery) which do not follow fixed routes. Therefore, a change in state policy is required to either reduce restrictions or devolve the power to the city government. The regulatory issues aside, it is assumed that stakeholders – residents and retail owners – will support these measures as there is already today relatively little pass-through traffic (as noted, Tompkins Square Park already serves as a barrier to them). Given all this, it is within the NYC Department of Transportation's powers to apply all the changes and access restrictions – but it should follow a comprehensive plan with engagement with the community board to understand the exact needs and concerns of residents and business owners.



9.2 10TH STREET & AVENUE A 2





PROPOSALS:

1. Widen Avenues/
   4 lane system with two car lanes and two "flexible" lanes

2. Adjust cross streets — one way only, alternate all-vehicle, AV only.

9.3 PORT AUTHORITY 1

Adam Lubinsky (WXY), **Chris Rhie** (BuroHappold), **Evan Bialostozky** (MTA Bus), **Megan Richer** (Via), **Savinien Caracostea** (Savinien)

Write-up by **Chris Rhie**

What is your team's idea?
CAVs offer the opportunity to dramatically reallocate street space to accommodate the needs of New Yorkers, which is especially important for Midtown West, where a large and diverse set of people pass by, under, or through the Port Authority Bus Terminal. Rather than restrict ourselves to the relative dichotomy of north-south Avenues and east-west Streets, we have the opportunity to create a much more nuanced organization that treats each roadway based on its role in facilitating mobility systems. Our team therefore proposes to "flip the pyramid" to prioritize access based on the following hierarchy of needs:

01. Mobility Impaired and Emergency Vehicles
02. Pedestrians and Bicyclists
03. Delivery CAVs
04. Transit CAVs (Bus)
05. Shared CAVs (Vans)
06. Private CAVs (Cars)

This organization begins with the most vulnerable road users, then parses out CAVs into freight and -passenger vehicle; we understand the vital role that delivery vehicles play in the city's economy and envision a future where they have room to operate safely, efficiently, and with minimal disruption. Passenger CAVs are further prioritized based on the numbers of people they serve. Buses have first priority as the most efficient means of transportation, and will have full BRT infrastructure including stations for loading and unloading. Shared CAVs are envisioned to fill the gaps where it may not be efficient to operate buses, such as during off-peak hours or routes that serve less dense areas such as eastern Queens. Private CAVs come last, and may even be restricted from Midtown West during times of the day when they would induce unacceptable levels of congestion.

Under this hierarchy, the Avenues will still move vehicular traffic north and south, but the types of vehicles would vary. Eighth Avenue, which has a subway line beneath it, would not have a busway but would rather dedicate space for Shared CAVs including pick-up/drop-off area in front of the Port Authority. Ninth Avenue would have BRT infrastructure – but also dynamic lanes that could allow the bus lane to be used by Shared CAVs in off-peak hours. All Avenues would undergo a significant "road diet" to increase comfort for non-motorized transportation.

The Streets become an even more interesting opportunity. We assume that a wholesale shift to shared mobility systems will be accompanied by a shift in attitudes – New Yorkers will not expect door-to-door service as they do now. They will be willing to walk to major corridors to board a Shared CAV, much in the way that Via riders today are directed to walk a short distance to optimize the efficiency of the shared ride. Every other side street will be closed to vehicular traffic (with the exception of delivery, Paratransit, and emergency vehicles), and the remainder will adapt the urban design of woonerfs to allow slow-moving CAVs. A limited number of Streets can carry cross-town Transit CAVs and Shared CAVs, such as 34th and 42nd Streets; just like the Avenues, dynamic lanes will alter access based on real-time demand.

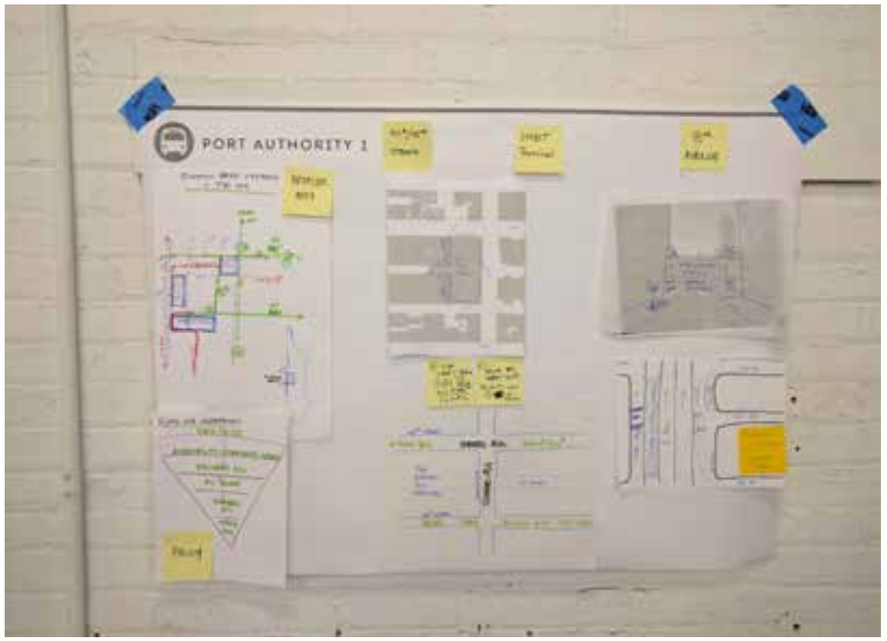
Finally, the Port Authority Bus Terminal will change as intercity buses adopt CAV technologies; efficiency improvements will mean it will no longer need to store large numbers of buses and cars. There will be clear and attractive multimodal connections for intercity travellers shifting to bikes, buses, and Shared CAVs. With a Shared CAV pick-up zone in front of the Eighth Avenue entrance, the building will have a grand lobby akin to Grand Central Station, which is clearly visible from the street. Retail spaces will be pulled to the interior of the Terminal, providing reason for people to visit and linger within. The rooftop will be transformed into a destination park, providing Midtown West with the grand public space that it so greatly needs – and providing a welcome respite for those waiting for the next bus.

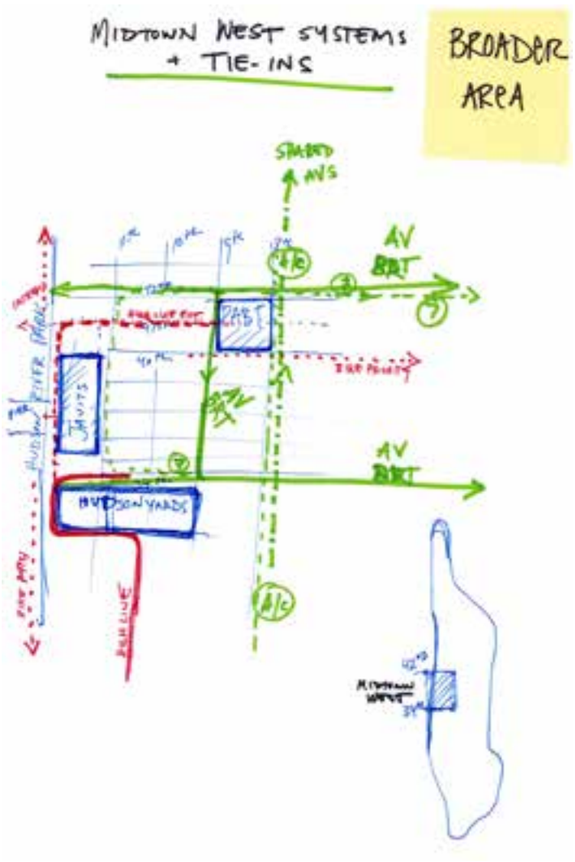
Why is this a good idea for your city?
The re-organization of the streets will improve safety for vulnerable road users, improve efficiency of movement by any mode, and increase the quality of life for New Yorkers by providing a more comfortable and less cacophonous experience at street level. An improved Port Authority Bus Terminal will serve to improve multimodal connections for intercity travellers, provide a much-needed destination open space, and provide a grand experience fit for one of New York City's major ports of entry.

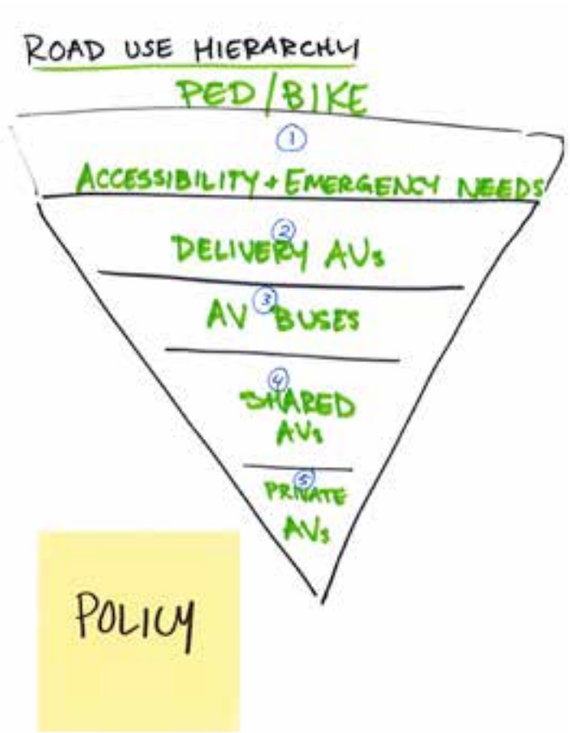
What would need to happen to implement your team's solution?
Flipping the pyramid will most likely happen incrementally. We are already able to start thinking about road pricing as a means of controlling access to streets based on time-of-day; connected vehicles will later allow us to start thinking about fine-tuning access restrictions in real time, but we will need to plan ahead to ensure the requisite infrastructure is in place.

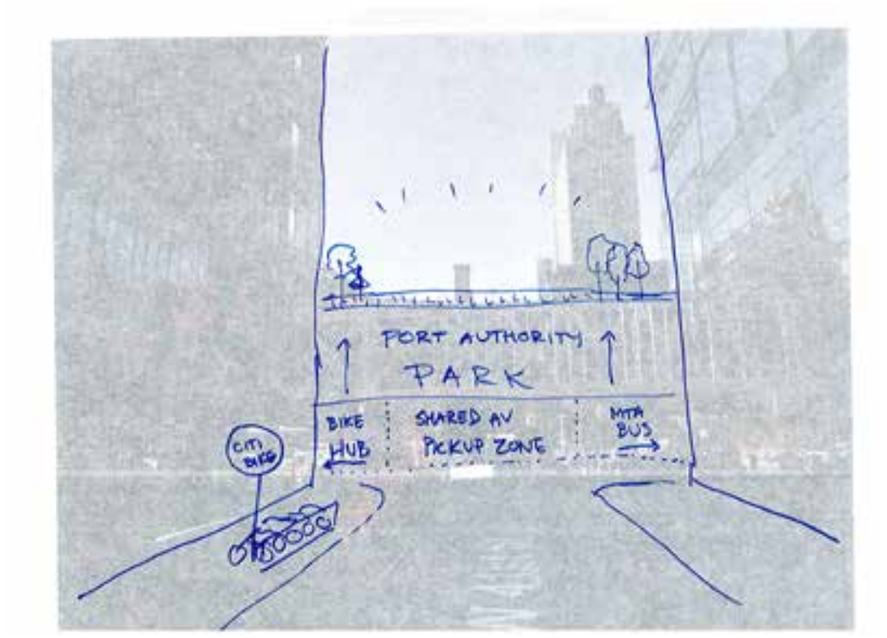
Politics has been described as who gets what, when, and how; ultimately strong political will is needed to re-allocate street space from private vehicles to Transit (BRT) and Shared CAVs. Special events such as Car Free NYC and Sunday Streets go a long way towards demonstrating benefits and easing hesitation about making such a change; these can be paired with CAV pilot programs as technology improvements take shape.

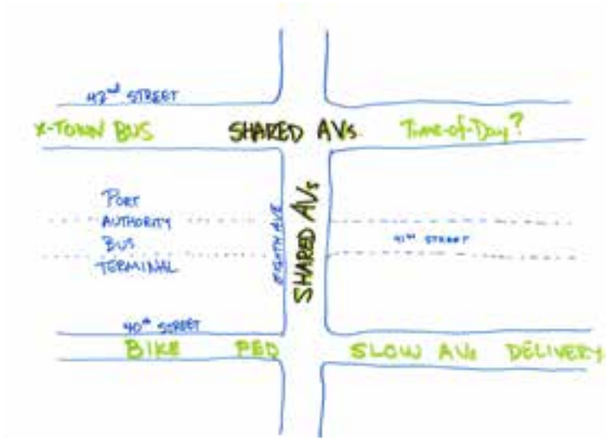
9.3 PORT AUTHORITY 1











9.4 PORT AUTHORITY 2

Gabriel Warshaw (BuroHappold), **Jackson Lehr** (National Grid), **Johan Schwind** (URBAN-X), **Karolina Czeczek** (Only If), **Zak Accuardi** (TransitCenter)

Write-up by **Gabriel Warshaw**

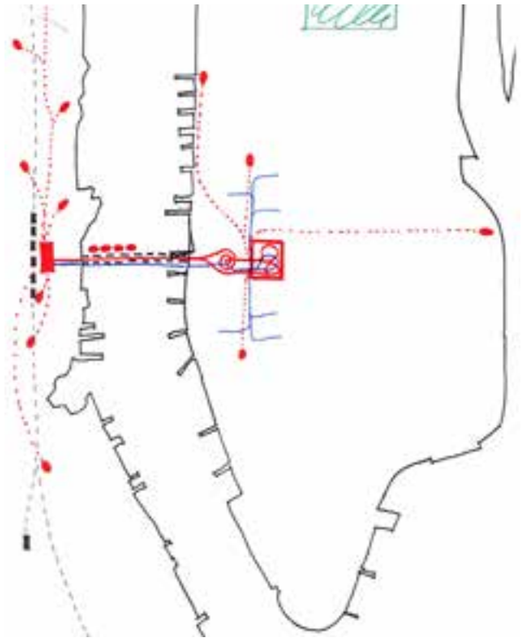
What is your team's idea?
With almost a quarter million bus users on an average weekday and access to eleven subway lines, the Port Authority Bus Terminal is one of the largest transit hubs in New York City. While the ability to accommodate the area's staggering traffic flows is a feat in and of itself, the terminal and surrounding streets are chronically congested. Eighth Avenue and 41st Street is a bottleneck for pedestrians, vehicular traffic, and a nightmare for bikers. To remedy this problem, our group designed a system to minimize and streamline passenger pick-up/drop-off in the terminal through the implementation of the "WeBus," an autonomous, shared, and connected bus system that aims to reduce transfers at Port Authority.

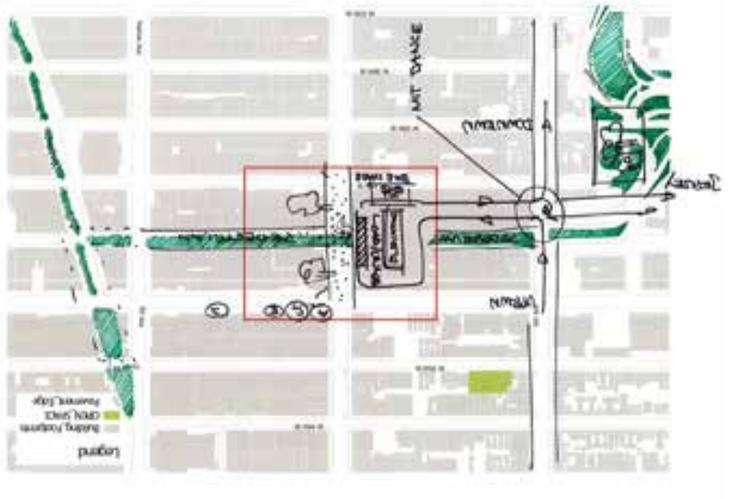
The WeBus is a modular mid-sized van that would operate in areas of New Jersey with high concentrations of commuters. Similar to other ridesharing platforms, users would request a pickup in New Jersey and share a ride into New York. However, as multiple WeBuses converge on the Lincoln Tunnel, they would aggregate themselves to form a train to optimize road space as they crossed into Manhattan. Once at Port Authority, the WeBuses would circle in a loop for a brief time in the terminal, giving passengers the option to get off or switch to a different WeBus. The buses would then split apart into smaller components, with each individual or aggregated WeBuses carrying passengers headed to similar areas of NYC or the tri-state area. This modularity would provide door-to-door service without requiring riders to switch modes of transportation or sacrifice the utility of larger buses.

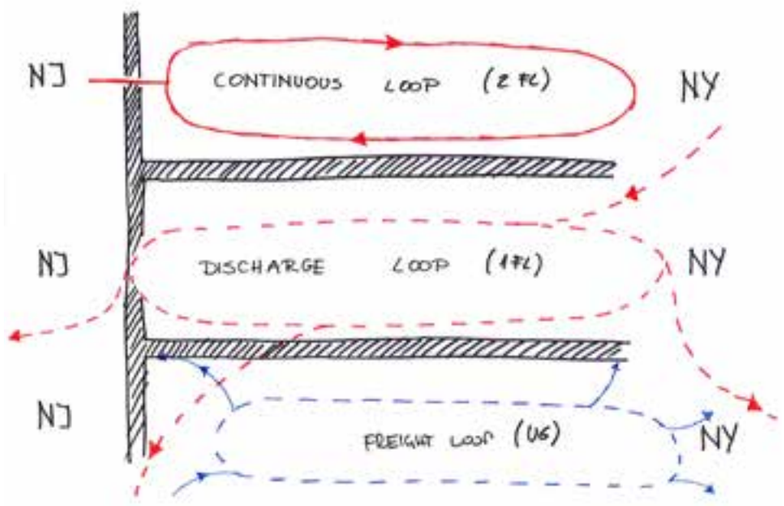
Why is this a good idea for your city?
The efficiency gained through the implementation of this system, combined with additional use of CAV technology throughout the city, would allow 9th Avenue to become a two-way street – acting as an entrance and exit point for all Port Authority bus traffic. Additionally, the WeBus would eliminate the need for bus storage in the area, which is currently at a premium, and allow 8th Avenue between 40th and 42nd Streets and 41st Street between 8th Avenue and Times Square to become fully pedestrianized.

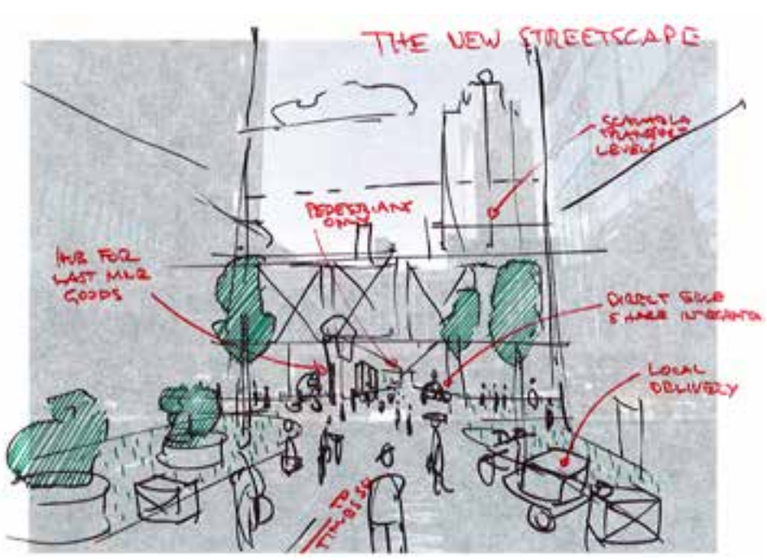
What would need to happen to implement your team's solution?
Our group is optimistic that CAVs will facilitate the development of customizable public transit infrastructure that improves safety, quality of life, and decongests the urban environment. However, this vision is contingent on regulatory support and continued advances in technology. Implementation of the WeBus would require the development of supporting infrastructure throughout New Jersey, the Lincoln Tunnel, and inside the Port Authority Bus Terminal itself. Additionally, advances in machine learning and AI would be necessary to fully automate the mechanisms that attach and detach WeBuses based on rider demand and destination. While these are legitimate hurdles, they are not insurmountable; successful integration of CAVs will require cooperation and support from all sides.

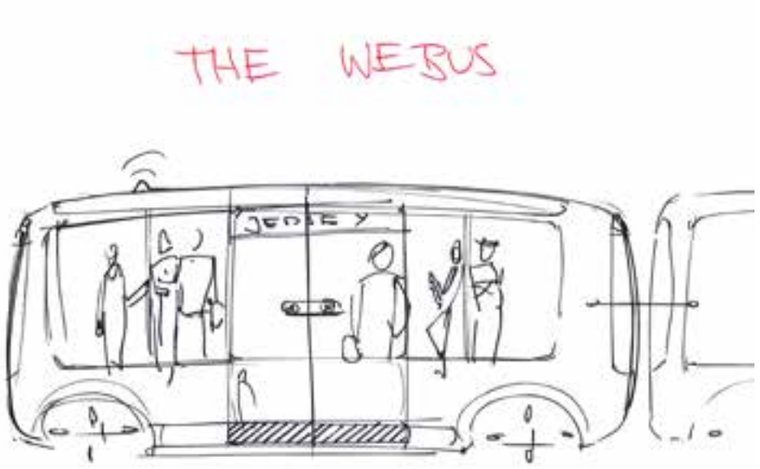
9.4 PORT AUTHORITY 2











9.5 GREENPOINT 1

David Vega-Barachowitz (Department of City Planning), **Michael O'Neill** (BBB), **Miriam Roure** (URBAN-X), **Sam Frommer** (Sam Schwartz Engineering), **Raj Diwan** (NYPA)

Write-up by **Miriam Roure**

What is your team's idea?
The designated site in Greenpoint exists at the northern end of the neighborhood, where McGuinness Boulevard starts to lift up to the Pulaski Bridge to cross over to Long Island City. The boulevard splits the neighborhood in two: on the east is a low density semi industrial area with a few lots where fleets of taxis and other vehicles are stored and repaired. On the west is a residential neighborhood that spreads to the river and is rapidly growing with new developments coming onto the market.

Our team's concept is called Greepoint to Greenhubs: we imagined a future in which autonomous electric vehicles (AEV) were fully embraced and we defined mobility as a utility. Our idea was to integrate charging and maintenance hubs throughout the neighborhood in such a way that vehicles would balance the grid by charging at times when the available supply of energy was at its highest. These hubs would also serve as maintenance stations – if the average car is only utilized 10% of its time, with autonomous driving, the utilization could go up to 40 or 70%. This means that repairs and maintenance could become key elements of our mobility infrastructure. A workforce programme would train people to maintain and repair the vehicles.

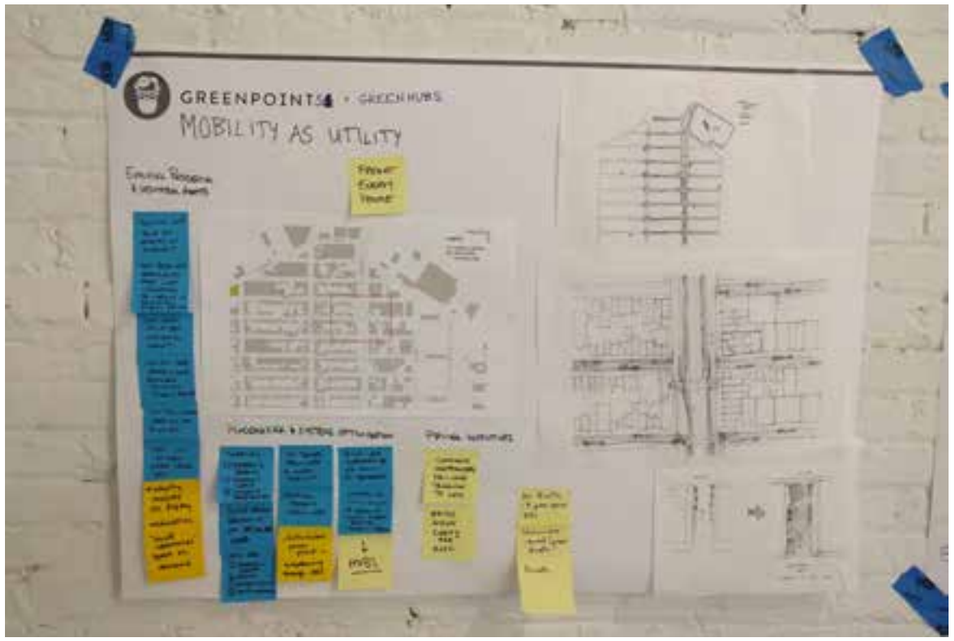
We also imagined bigger hubs that acted as local distribution centers for cargo deliveries – so instead of having trucks pulling up to people's homes, smaller intelligent vehicles would come up. Streets would become bi-directional and "programmable" depending on the day or time.

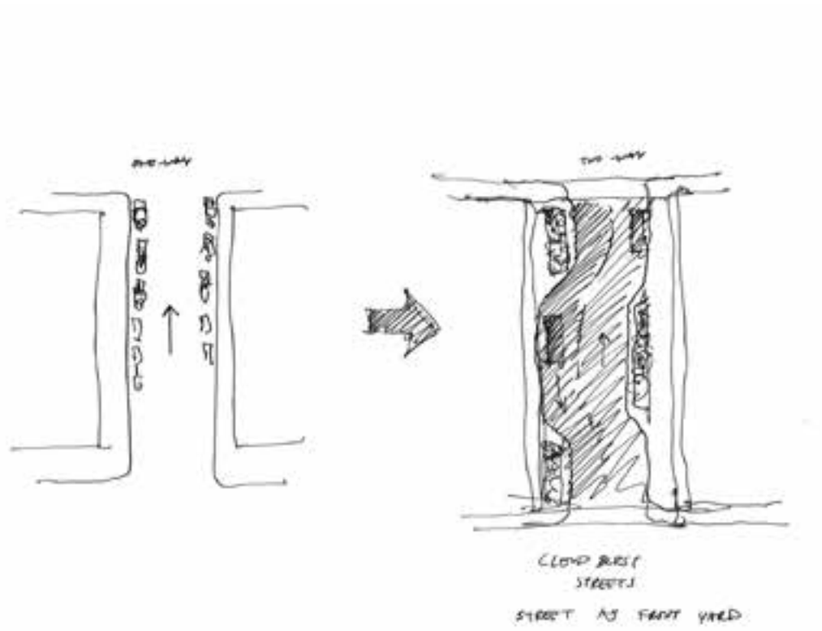
Why is this a good idea for your city?
Greenpoint sits at a strategic location in the city – it's very well connected and sits at the intersection between different neighborhoods. It could become the power supplier for the vehicles running around other parts of Manhattan, or at least a testing ground for such.

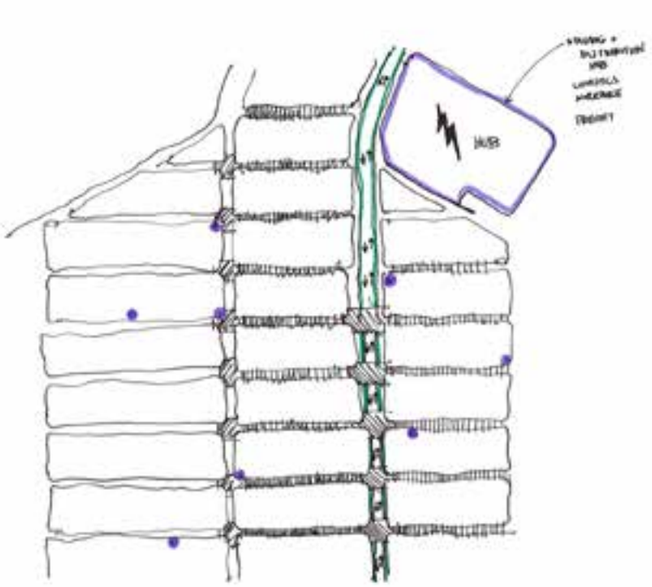
We cannot think of AEV without thinking about the power demands for the infrastructure. Given the major infrastructure transformation needed, there is an opportunity to rethink how the power grid works and how it manifests on the street level. A low density neighborhood such as Greenpoint is great for testing different solutions.

What would need to happen to implement your team's solution?
For these hubs to be implemented we would need significant technology and policy changes. On the technology side, we would need the electrical infrastructure as well as new passenger and cargo vehicles and autonomous driving technology. On the policy side, we would need to have regulations both for energy distribution and pricing, and for autonomous driving technology to be allowed and supported.

9.5 GREENPOINT 1







9.6 GREENPOINT 2

Cecilia Zironi (rePLACE), **Jaclyn Hersh** (BuroHappold), **Maria Aiolova** (TerraformeONE), **Sandar Dolder** (EDC), **Varun Adhibatla** (Argo)

Write-up by **Jaclyn Hersh**

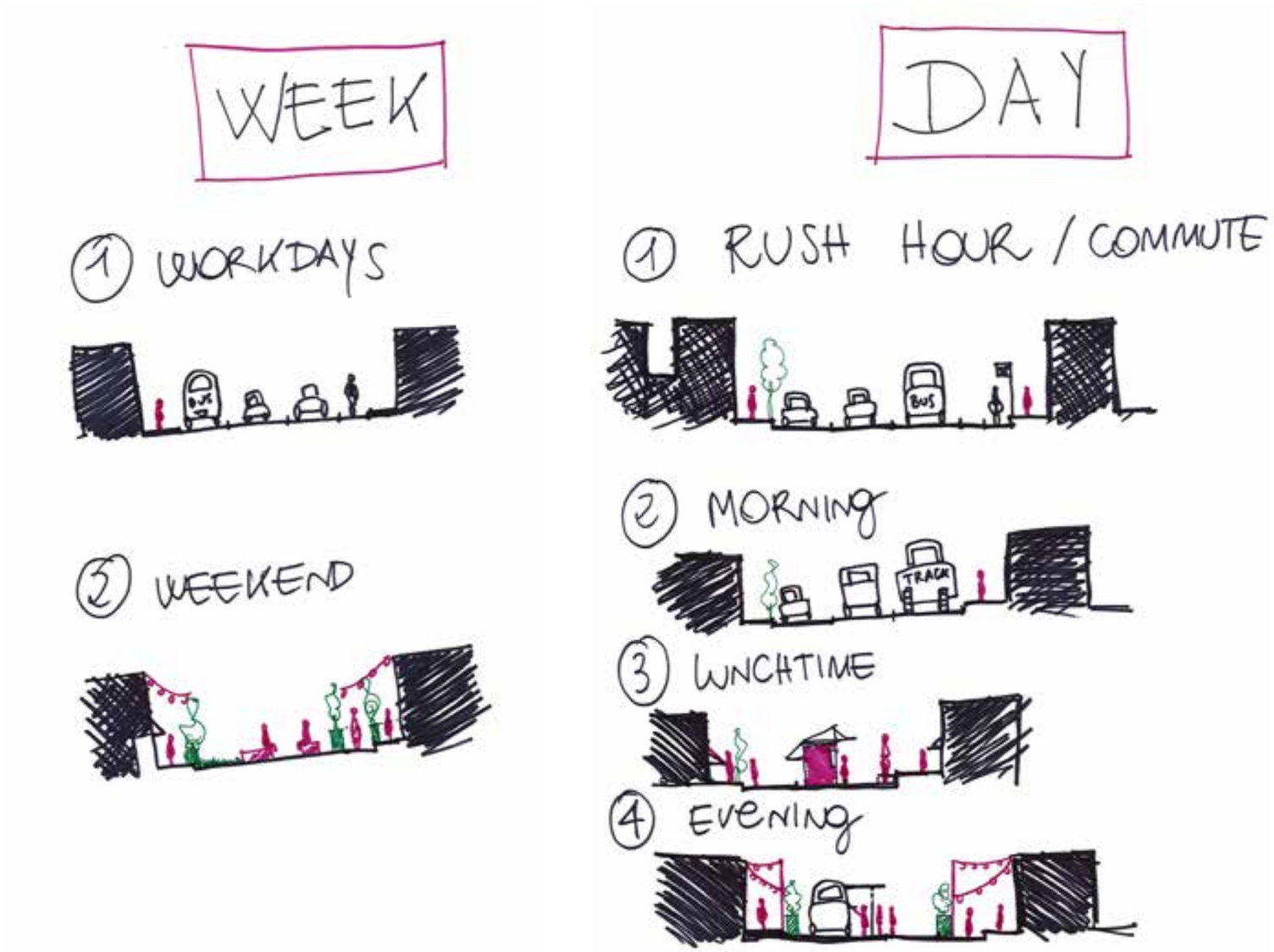
What is your team's idea?
McGuinness Boulevard is a main thoroughfare running through North Brooklyn, from the Brooklyn Queens Expressway to the Pulaski Bridge which leads into Queens. Greenpoint is a historically industrial neighbourhood that has seen much change in recent years with new developments geared towards makers' spaces, new cafes and restaurants, and an influx of younger people and families. McGuinness Boulevard is two lanes in both directions and quite busy, offering little safety for bikers and an unfriendly environment for pedestrians. Our team proposed to reimagine this space, McGuiness Boulevard at the base of the Pulaski Bridge, into Flo Intel Street building off the development of the Brooklyn streetcar (the Brooklyn-Queens Connector) which is proposed to run along McGuinness. With the introduction of the streetcar and with the introduction of connected and autonomous vehicles (CAVs) we proposed making this space a corridor of transport yet also a destination for human interaction and activity, where all elements beyond cars are connected. This will ensure that this chaotic section and heavily trafficked area, currently a desolate space to pedestrians, will become safe, active, and attractive.

We also proposed that this space can become multifunctional given its technological connections. In the morning during rush hour we can open up more lanes to ensure an optimal flow of traffic, which includes trucks driving into Queens. In the mid-morning, the street can change its character and landscape, having automated trees emerge to re-appropriate McGuinness Boulevard for a bit more human activity. During lunchtime and in the evening after rush hour, again more space will be re-sectioned for pedestrians and human activity – space for farm stands and pop up markets will now be available. This will turn a desolate highway into a destination for the neighborhood, a space that people will want to interact with as opposed to avoid. On the weekends we imagined that McGuinness Boulevard can be completely turned over to people and closed to cars.

Why is this a good idea for your city?
McGuinness Boulevard is a main route for travel from Brooklyn to Queens and vice versa, both for shipping goods and for personal travel. We think it necessary to have this passage, and though we considered giving the Boulevard completely to cars or completely to pedestrians, a middle ground can serve two purposes without disrupting the flow of traffic. Having the space be connected means that it can be efficient and serve transportation needs, yet be safe for people as well. Children can play as autonomous vehicles will sense any potential obstacle. Furthermore, being a major junction, we proposed that cars primarily use this route, using side streets only for pick up and drop off. This will limit traffic on side streets making them safer and more pedestrian friendly. Another added benefit is that there are times when the Boulevard is heavily flowing with traffic, and times when the street is less trafficked as in the mid-day or evening. Having flexibility built into the street so that it can function in a variety of ways at different times of day ensures that it serves the community better and more continuously as an active and functional space.

What would need to happen to implement your team's solution?
To implement Flo Intel Street we will first need the technology to make such a connected street possible, technology beyond CAVs to make the streets themselves connected to the surrounding environment and people moving in this environment. Another vital part of implementing this scenario involves input from the community to identify how the street can best be used during its off hours from cars. Does the neighbourhood need more food options? Does it need more retail? Answers to these questions will guide the development of the street so that it can best serve the community and their current needs.

9.6 GREENPOINT 2



9.7 COLUMBUS CIRCLE 1

Mariane Jang (100 Resilient Cities), **Micah Kotch** (URBAN-X), **Oliver Schaper** (Gensler), **Patrick Kalaher** (FROG Design), **Rodney Stiles** (TLC)

Write-up by **Micah Kotch**

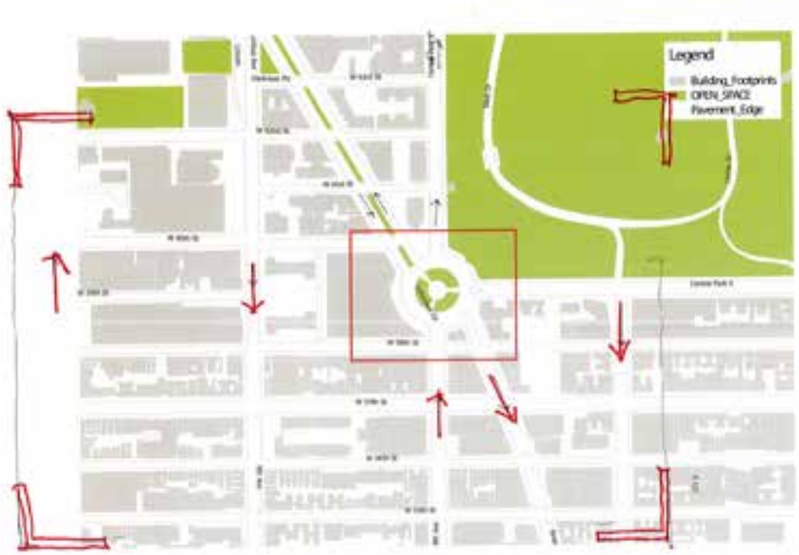
What is your team's idea?
Columbus Circle is a major thoroughfare and tourist destination in the heart of midtown Manhattan. It is a major transportation connection point for the MTA and a vehicle priority arterial serving as the major chokepoint for traffic heading downtown via Broadway and uptown via Central Park West. It also serves as a cultural touchpoint, hosting a museum, a large Whole Food market as part of Time Warner Center, and a gateway for Central Park. Because commercial traffic is relegated to Broadway on the West Side, Columbus Circle is a traffic choke point occupied by taxis, high income local residents, and the occasional horse-drawn carriage. We looked at the CAV technology as an opportunity to reimagine Columbus Circle as a place designed for cars to one designed for people.

Our concept focused on the pedestrianization of the Circle through dynamic pricing. By shifting priority to autonomous vehicles, Columbus Circle could shift its usage pattern and allocate lanes to bikes, pedestrians and vehicles through 'micro surge pricing' and flexible infrastructure. In our vision, the surrounding streets in the neighbourhood could host bi-directional traffic while significantly decreasing or eliminating street parking. We explored the idea of residential 'super blocks' which would allow larger sidewalks on surrounding streets and more room for bicycles.

Why is this a good idea for your city?
Local drivers tend to avoid Columbus Circle at all costs. It is widely known as a chokepoint and a trap for rubber-necking. With the failure of congestion pricing, a smart scheme to test demand pricing for autonomous vehicles could be scalable in other locations across the City. Commercial traffic could be incentivized to avoid busy morning and afternoon hours by a similar pricing strategy. Parking garages on surrounding streets, which would likely see less demand, could be repurposed to serve as urban agriculture locations, providing raw ingredients for autonomous food trucks serving tourists and office workers or the local Whole Foods. Our vision would increase the commons and provide benefits for larger groups of people as opposed to serving the needs of the few.

What would need to happen to implement your team's solution?
Implementing a plan for autonomous vehicles in Columbus Circle would require buy-in from the Department of Transportation, the local Community Board and Business Improvement District, the Secret Service (because of Trump Tower – for now) and other adjacent property owners. The technical requirements to provide dynamic price signals would require a standard adopted by all automotive OEMs, a high-speed and secure wireless network, and real time data relaying street conditions. Implementation would require grass roots support from both the business community, cultural institutions like the Central Park Conservancy, and local residents in order to provide political cover for the Mayor and City Council to bring this concept to life.

9.7 COLUMBUS CIRCLE 1



9.8 COLUMBUS CIRCLE 2

Derrick Choi (Populous), **Greg Lindsay** (Fast Company), **Mike Seyle** (BuroHappold), **Nicola Thomson** (100 Resilient Cities), **Patrick Smith** (NYC Department of Transportation)

Write-up by **Derrick Choi**

What is your team's idea?
Columbus Circle is an icon that can never be truly occupied. Traffic roundabout, NYC landmark, and post card icon – right adjacent to Central Park, but never a part of it. In the dawn of connected and autonomous vehicular networks, the time to reimagine the Circle is now. Imagine finally being able to occupy Columbus Circle AND enhance traffic flow? Our concept seeks to do just that by physically integrating Columbus Circle with Central Park to enhance the pedestrian experience, improve the flow of transit, and introduce a new proving grounds for CAVs and delivery vehicles south of Columbus Circle along Broadway.

There are some fundamental planning assumptions behind the concept:

1. Re-routing traffic flow will enhance traffic while improving open space.
2. The improvements seek to balance – to the extent practicable – the interests and operational requirements of pedestrians, bicyclists, public transit, personal vehicles, CAVs as well as public-private development opportunities.
3. Public policy shall be innovation-friendly and will encourage testing extant infrastructure to adapt to new technologies and solutions.
4. Connected and autonomous vehicle networks will be an integral component of the City's transportation system.
5. Public private partnerships are encouraged to advance innovative infrastructure and urban ideas.

We offer a multi-phase approach to stitching Columbus Circle into Central Park. The multi-stage strategy gives the City the flexibility to test concepts with little risk:

PHASE 1 – Absorb the Roundabout

- Shut off quadrant facing Central Park with retractable bollards and paint the street; creating a contiguous public space extension; stitching Columbus Circle to Central Park.
- Re-route traffic flow in a north-south configuration: Broadway (north of 58th) to Central Park South provides a south flow while Broadway (south of 58th) to Central Park West provides a north flow. NOTE: South-bound traffic flow is diverted to Central Park South.
- Broadway South of 58th Street will be cut off of traffic on a regular basis as a test corridor for CAV technologies – especially for off-hour test runs of delivery robots originating from the Columbus Circle Whole Foods – running down all the way to Union Square.

PHASE 2 – Absorb the Streets

- Shut off all of Central Park South and the entire roundabout from Broadway to the start of Central Park West from vehicular traffic; effectively repurposing about HALF of the Columbus Circle roundabout into public open space.
- Re-route traffic flow permanently in the following manner:
  - South flow: Broadway to 8th Avenue
  - North flow: 8th Avenue to Central Park West
  - East / West flow: turn at 57th and 8th Avenue
- Dedicated South Broadway route (south of 57th Street) for CAV and pedestrian-centric activities.

While the Circle goes away – almost half of it becomes absorbed by Central Park – the operational and quality of life improvements are considerable. At the new Columbus Park, traffic improves, Broadway and Central Park South becomes dedicated for open public space and a new north-south axis for traffic is provided.

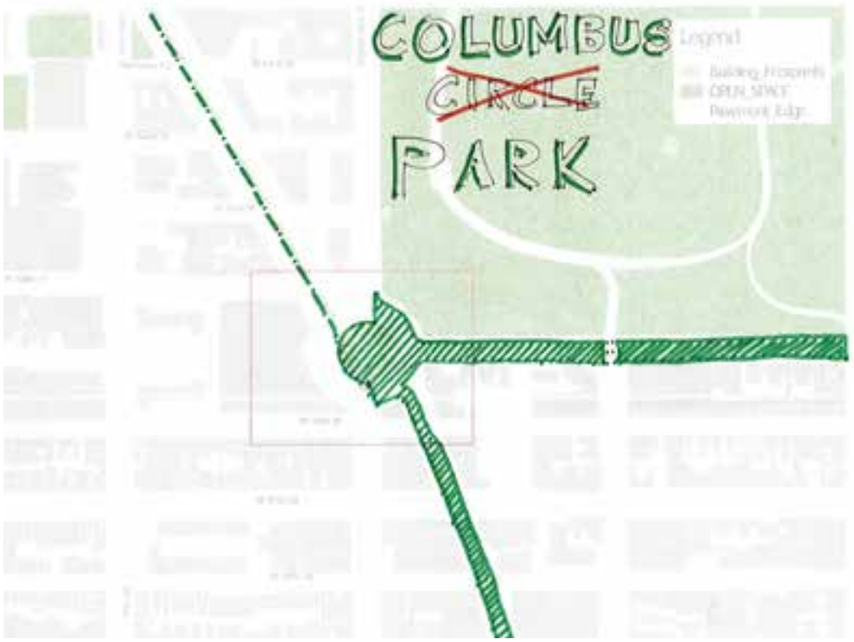
Why is this a good idea for your city?
Columbus Circle's riddle is solved once and for all when traffic improves and the quality of public life can be improved at the site. We believe there are 4 primary benefits worth thinking about:

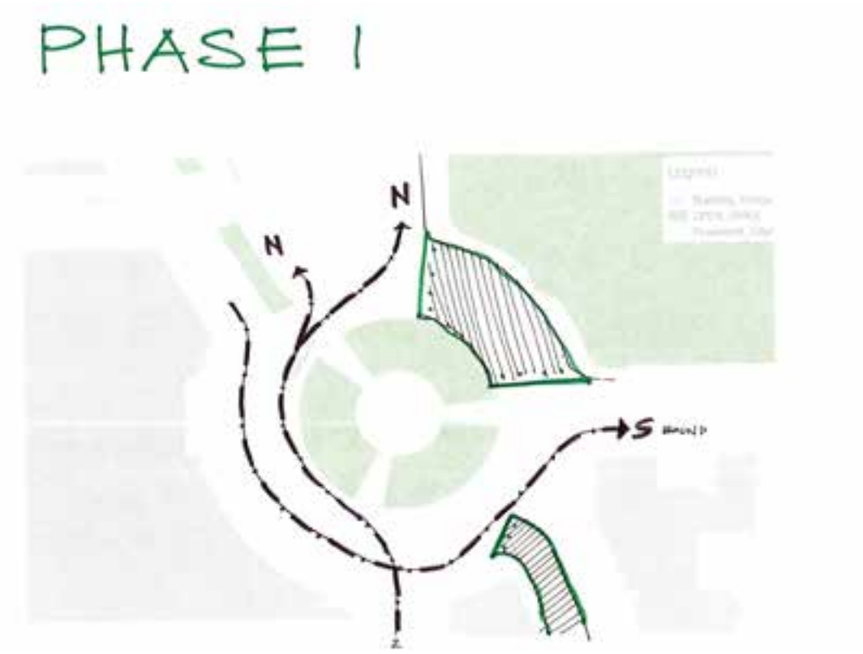
1. Introduction of dynamic new public spaces – Central Park South becomes a dedicated pedestrian-only public corridor and Columbus Circle becomes a truly public space with no traffic disruption.
2. Commitment to a new dedicated Broadway technology corridor from the Circle to Union Square – providing a new test bed for CAVs while recommitting to the public realm.
3. Significant traffic and environmental enhancements – re-alignment of the North-South flows will eliminate congestion, idling, and overall air quality for the immediate area.
4. Encouragement of strong public-private collaboration – from delivery robots from Whole Foods to new private sector sponsorships of new public corridors, new opportunities to reclaim the streets will deliver incredible dividends for the City.

What would need to happen to implement your team's idea?
No idea can be implemented in a vacuum. The successful implementation of the Columbus Circle concept will weigh heavily on the ability of the City to be able to test these ideas in such a heavily trafficked location that must last the test of both pedestrians as well as vehicles.

There will likely be a combination of aggressive, phased testing and recalibration of the test corridors as well as strong policies advocating for innovation and public-private partnerships. Implementation will require a two-fold collaboration between public agencies who must test the corridors and implement the policies and the private sector players who need to understand the needs of their stakeholders.

9.8 COLUMBUS CIRCLE 2





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