

PULSE

ENLIGHTEN

"FREE TRANSPORT
IS OFTEN THE SHORT-CUT
OR SHORT-TERM OPTION"

EXPLORE

THE POWER OF
ELECTROMOBILITY

ACCOMPLISH

RIDING THE TREND

HOW BIKES ARE CHALLENGING
THE MIGHTY AUTOMOBILE

INSPIRE

CAPTURED LIVE





***PULSE* IS INTENDED FOR ALL
STAKEHOLDERS, DECISION
MAKERS AND OPINION LEADERS
OF EVERYDAY MOBILITY. A KEOLIS-
LED INITIATIVE, THIS BIENNIAL
MAGAZINE AIMS TO FUEL DEBATE
AND GENERATE DISCUSSION ABOUT
THE TRENDS AND CHALLENGES THAT
ARE SHAPING OUR INDUSTRY.**

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The world is undergoing great change. Shared mobility is changing too and will play an increasingly decisive role in our lives.

Until now, the objective of those involved in mobility could be simply defined as creating solutions to resolve an issue to deal with the number of passengers being carried. Today the time has come to bring the human element back to the heart of transport systems. I often say that the needs of the individual should not be forgotten in mass transit. On the contrary, we must get better at understanding them and getting to know the regions in which they live and evolve, in order to better understand their habits, needs and preferences.

At the same time we cannot pretend to imagine a specific response for each particular individual's case. We need to work against the flow in order to decypher every single bit of information with curiosity and open-mindedness, so that we can identify underlying trends and find solutions to improve mobility for everybody. A fascinating challenge!

Pulse is a perfect tool for this observational and innovative approach. In this issue you can read articles and opinions about subjects as varied as electromobility, free transport, the Millennial generation's mobility trends and the festival that transforms Melbourne's trams into authentic artworks. A mass of ideas to reflect on and inspire all of those with an interest in shared mobility.

ÉRIC CHAREYRON,
CEO of Keoscopie Observatory of Mobility Trends

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Emmanuel Couet

Chairman of Rennes Metropolitan Area (France)

Active in politics since the age of 17, Emmanuel Couet was elected Chairman of the Rennes Metropolitan Area (450,000 inhabitants) in 2014. Since then he has crafted its reach and is convinced that efficient transport systems and the freeing-up of public space can create value for cities. For *Pulse* he talks to us about his vision of urban mobility and the innovations that have been introduced in his area to reinforce the provision of public transport and reduce the use of private cars.



Matthias Finger

Researcher and professor at the Ecole Polytechnique of Lausanne (Switzerland)

Specialist in the management of network industries and transport regulation, Matthias Finger is notably a professor at the Ecole Polytechnique of Lausanne. In 2014 he became director of IGLUS (Innovative Governance of Large Urban Systems – iglus.org), a training programme supported by Keolis, whose objective is to help cities improve the governance of their infrastructure. He has written an opinion column for *Pulse* in which he discusses the role of public transport authorities in regard to the challenges they face from the digitalisation of mobility.



Charles Bombardier

Engineer and founder of Imaginative (Canada)

Grandson of Joseph-Armand Bombardier, founder of the eponymous industrial company, Charles Bombardier is no typical engineer. Based in Quebec, his non profit-making association, Imaginative, collaborates with industrial designers from all over the world. Their objective is to imagine together the vehicles of tomorrow. To date, 300 concepts have been studied. The only limits to Charles Bombardier are the limits of his own imagination.



Yves Crozet

Transport economist, Professor and research fellow in Lyon (France)

Specialist in transport economy, Yves Crozet is an economist, professor emeritus at the University of Lyon and research fellow at the Centre on Regulation in Europe (CERRE). He talked to the *Pulse* team about the issues of free public transport. This should provide public transport authorities and other urban stakeholders with valuable food for thought.

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DIGITAL URBAN MOBILITY:

what role for the transport authorities?

by Matthias Finger



Digitalisation affects all human and industrial activities worldwide. Digitalisation consists of three closely linked dimensions, namely (1) data generation and storage (from more and more sources and in bigger and bigger quantities), (2) data exchange (bigger volumes, increasingly in real time) and (3) data analysis (bigger amounts of data, thanks to more and more sophisticated algorithms).

This purely technological evolution enables the emergence of so-called “digital platforms”, where data about physical activities are stored, exchanged and analysed. These platforms are establishing themselves as the new intermediaries between the users or customers of a physical service and the physical service provider itself. Let us take three globally recognised examples of such digital platforms. Amazon used to be a digital platform intermediating between book producers and readers (buyers of books). It has since become an intermediary between almost any producer of a physical (retail) good and almost any buyer of such goods. Spotify is an intermediary between a music producer and a listener (consumer

of music). And Airbnb is an intermediary between a renter of an apartment and person (customer) seeking to rent such a space.

The same technological evolution can potentially be applied to urban mobility, and, as a matter of fact, is already being applied. So-called “mobility platforms” are seeking to establish themselves as intermediaries between the providers of transportation services in the various transport modes and the users or consumers of such services (passengers). Initially, such platforms solely offered information about public transport offerings, such as timetables, increasingly in real time. These platforms then evolved into offering ticketing services. But now, we see the emergence of even more sophisticated platforms offering so-called “mobility services”, travel services across modes, whereby a user can be transported from A to B in an integrated and seamless way (e.g., “Mobility as a Service” or MaaS).

As in all such digital platforms two basic economic principles apply, namely so-called “direct” and “indirect network effects”. We actually know “direct network effects” already from the traditional physical world:

basically the value of a (physical and digital) platform goes up the more users or customers are connected to it. The more citizens are connected to the postal network, the higher its value to everybody who is connected; the more users are connected to a telephone network, the higher the value for all the users and of the network itself. Applied to a mobility platform, this means that the more transport modes and transport offerings are connected to the platform, the higher the value for all the (potential) users. “Indirect network effects” come on top of direct network effects and result from the analysis (by the platform) of both the users and the producers. The more knowledge we have about the users, the more valuable the platform becomes for the producers, and the more (quality) information we have about the producers, the more valuable the platform becomes for the users. Both, direct, but especially indirect network effects are strong drivers of monopolisation, a phenomenon also called “winner takes all”. In other words, there is generally only room for one digital platform in a given domain, meaning that, for purely economic reasons, there is typically only room for one digital mobility platform in one urban or metropolitan area. Thus, the mobility platform that manages to be first on the market will prevent the survival of other competitive mobility platforms or even simply their emergence.

But what does this all mean for public transport authorities? It is obvious that such digital mobility platforms are of utmost interest for transport authorities and cities more generally. They contribute to organising urban transport more efficiently, reduce emissions, tackle congestion and increase safety. More generally, they also reduce car ownership to replace it with more sustainable intermodal mobility. On the other hand, it is unlikely that transport authorities will be able to develop such (digital) mobility platforms by themselves, let alone evolve them into a viable business model. This can, in my opinion, only be done in collaboration between the transport authority, the various transport services providers (some of which may be owned by the transport authority) and digital mobility platform developers and operators. The latter are most likely



Illustrations: Bénédicte Govaert (L) – Émilie Seto (R).

international companies that have already been able to learn from similar experiences elsewhere.

Nevertheless, I strongly advocate for a public policy or public service perspective when it comes to digital urban mobility platforms. Conversely, I am not advocating for a purely commercial approach to digital urban mobility (platforms): while a purely commercial mobility platform operator will ultimately want to maximise mobility by exploiting to the maximum the direct and

indirect network effects, a transport authority seeks to promote the public interest, which, in this case, is to reduce the use of the private car for environmental, public health or simply efficiency reasons. From this public policy perspective, thinking in terms of integrated mobility, door-to-door transport and ultimately Mobility as a Service does make perfect sense. It is therefore cities and metropolitan areas that have to promote mobility through mobility platforms. This means that they have to plan for them, create the institutional conditions for them and most probably also contribute financially to them. ●

RENNES, INNOVATION ACROSS ALL LINES

Rennes tops the league of the best French cities to live and work in⁽¹⁾. For sure, being close to the sea, the air quality and the cultural choices on offer, are some of the reasons. But the economic strength and the share of population that use public transport are also part of the ranking criteria. Having said that, if you think about it, isn't there a link between these two points?

by Ingrid Labuzan

Rennes Metropolitan Area ID CARD

- Over **450,000 inhabitants** living in 43 municipalities.
- **Demographic growth:** + 6,000 inhabitants every year.
- **Unemployment rate:** 7%, 2 points less than the national average.
- **2 metro lines by 2020** (the 1st opened in March 2002).
- **72 regular bus lines.**
- **900 hire bicycles** with 83 docking stations.

“

Economic success and mobility are linked and these links will only become stronger in the years to come”, Emmanuel Couet affirms with strong conviction. Elected Chairman of the Rennes Metropolitan area in 2014, he is one of several who have crafted the success of the Metropole to make it a magnet of attraction nationally.

“The city of the future is one with a centre accessible from the outskirts and where intercity travel is seamless. If we look forward 10 years, I think this will be the number one point of attraction, particularly for young working people. This will have direct repercussions on the creation of economic, social and cultural value and enable the emergence of urban centres, ripe for innovation. If you want proof, you only have to look at some of the towns in Northern Europe or Germany: the most dynamic ones economically are those who have the boldest mobility and transport policies.”

Talking of bold decision-making, the city of Rennes has recently taken several. These are big challenges for this valley of 450,000 inhabitants which has to simultaneously anticipate population needs, maintain the pioneering position it occupies in the transport field and manage the consequences of its popularity. The multi-modal network has already been awarded the Golden Transport Pass for efficiency three times over by the monthly magazine “Towns, Rail & Transports”.

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(1) Source: study of best French towns to live in, published by the French news magazine *l'Express*, 19.02.2018.

“The Rennes Metropolitan area has a long history of innovation in transport terms but that doesn’t stop us from being at a pivotal moment right now, confirms Emmanuel Couet. The region welcomes 6,000 new inhabitants every year. Imagine how many people that represents for a public transport delegation contract in seven years!”

A contract awarded once again to Keolis in 2017. In order to respond to the challenges of economic appeal and population growth, the city and its partners are working on a global response based on residents’ usage habits. “It’s no longer possible to think in terms of public transport if we exclude passenger habits connected to car use. It is also essential to harness the benefits of new technologies, with digital and smart data. Mobility must be seen as a whole, like a service linked to others, all making people’s lives easier,” Emmanuel Couet states ambitiously.

INNOVATION, THE PLATFORM FOR MOBILITY

In a year’s time, the city of Rennes will adopt a new Urban Mobility Plan. Its principal objectives will reflect Emmanuel Couet’s vision of mobility. Put together following consultation with the region, the department, the state and neighbouring municipalities, the objective of this



▲ One million euro investment in bicycles! With 63 km of express bicycle networks (16 km in Rennes), the city has woven a tight web linking up its municipalities. And offers a great incentive with 1,900 electric bicycles at preferential rates. Enthusiasm is such that an additional 1,800 electric bikes are planned. You’ll find them at the ‘Bikehouse’, run by Keolis.



urban mobility plan is behavioural change. An ambition to be achieved primarily by expanding the multi-modal network of public transport.

In this context, we would have to mention the opening of the second automated metro line – line B in 2020. This will enable 70% of the city of Rennes’s inhabitants (that will be 230,000 residents) to be situated less than 600 metres’ distance from a station. A great next step for encouraging public transport use and making journey times quicker.

This new line represents undeniable progress but is not the only example. Rennes is determined to continue its inter-modal efforts with its transport service. The emphasis is on the buses with the Metropolitan Innovation Pact signed with the French government in January 2017.

Buses are perhaps not the height of innovation? On the contrary. Services for surrounding areas are to be increased. But above all, the fleet is undergoing a major transformation towards 100% electric. Indeed, the Innovation Pact provides for a move to electric between now and 2025 to

2030 thanks to the partnership deal signed with the building consortium, Bolloré.

—//—
The main objective of Rennes’ new Urban Mobility Plan, to be adopted in 2019, is behavioural change. An ambition to be achieved primarily by expanding the multi-modal network of public transport.

Bicycles will also go electric. These will play a crucial role in our Rennes Metropole, designated as an “archipelago”. “In addition to urban bicycle hire schemes available in the city centre, we are encouraging long term hire of electric bicycles with preferential renting conditions. Today the fleet is composed of 1,900 electric bikes. We will make a significant investment in order to expand the fleet by 1,800 additional electric bikes per year. This kind of bicycle will be the perfect mode of transport for linking up municipalities of between 5 and 10 km in distance. At the same time, we are also in the process

▼ In Rennes articulated buses are a tradition, not so easy to transfer their engines to electric power. The challenge lies with Bolloré who will need to adapt its electric vehicles to the characteristics of the Rennes network. The city will then propose a consultation to evaluate the number of vehicles required for a 100% electric fleet.



▲ Innovation is a state of mind! This is why Keolis Rennes created PlayMobile, a workgroup dedicated to innovation for the Rennes area. And because the subject is vast, its members are diverse such as the University of Rennes and the Tourist Office. On the agenda, ideas, action plans and a budget that can be rapidly activated with the agreement of the Rennes Metropolitan Area. Amongst the projects being looked at, there is a community proposal which would enable people who do not want to travel alone, to travel together.

of developing an express bicycle network of 16 km across the city which will enable riders to travel between the city outskirts and the centre in 15 minutes”, Emmanuel Couet illustrates.

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With innovative projects such as electric buses and bicycles as well as a reinforced use of data, it’s a smart network that is being woven together.

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So it’s a smart network that is being woven together with these initiatives which have all been designed to respond to the expectations of Rennes city dwellers. They have been researched and analysed in opinion polls carried out in situ or by telephone, particularly in the context of the public service delegation contract. “Constructing mobility policy for all travel, whatever the mode, from the viewpoint of the customer, is a ‘no-brainer’,” is the message that Emmanuel Couet hammers home.

SMART DATA SUPPORTING THE “METROPOLITAN ARCHIPELAGO”
If innovation is the name of the game, it is not just restricted to transport and also applies to ticketing and payment methods. It is impossible to design a global mobility service without thinking digital and smart data.

The city of Rennes understood the importance of data long ago as it is the first French city to have embraced Open Data nearly ten years ago.

As regards transport cards, Rennes is streets ahead with its KorriGo Services. “Rennes Metropole is a pioneer of the national system AMC (multi-citizen application) which allows for the addition of services on a transport card,” explains Mylène Périidy, Rennes Metropolitan Area Transport Manager. These work on a regional level and enable other councils to add on various services, like swimming-pool or media library entrance costs, or even pay school dinners or childcare.



▲ 2020 will be the opening year for the metro line B, stretching from south-west to north-east. Due to high passenger numbers forecast, the amount of spaces in car-parks at the end of each metro line are to be increased. Between now and 2024, annual passenger numbers on public transport in the Rennes area, is set to increase from 83 million to 112 million.

A huge success considering that for 650,000 travel cards in circulation in the region, 250,000 of these are used in the city area.

From car manufacturers to network operators, including regional start-ups, all the actors of the economic fabric are asked to contribute their own digital building block. **“We work in a context of transparency and accessibility to public data – within a regulated framework of course – so that each of us can benefit from this data and build new applications, new urban services,”** adds Emmanuel Couet enthusiastically. The first result of this is the new STAR application launched in March 2018 which provides far more sophisticated services than current route planner calculation apps.

Given that Rennes mobility policy illustrates a very clear picture of modernity, it is out of the question to leave other residents by the wayside. Since January 2017, the city has introduced progressive, solidarity-based pricing. **“Pricing is household and means-related,”** adds Mylène Péridy. **The threshold for those eligible has also been raised, in particular for grant eligible students. The number of students benefiting from this measure has risen to 75%. It’s not just down to price, it’s also due to information campaigns carried out in tandem with Keolis and the online approach.”**



▲ Keolis Rennes works with the Wi6labs start-up to create connected products which will collect real-time information over the network. One of the scenarios imagined is to monitor transport system congestion and propose alternative travel routes to passengers.

inOut: digital mobility in the spotlight

Last March, the Rennes Metropolitan area and the region of Brittany provided visitors with an overview of the innovations originating from transport and digital collaborations. In particular, the inOut exhibition enabled visitors to immerse themselves in a 3D vision of the Rennes transport network, giving them an idea of smart vehicles of the future or updating their smartphone with the latest generation mobility apps.
<https://www.inout2018.com/>

The city of Rennes, Keolis and the University of Rennes have also coordinated efforts to work on a better organisation of timetabling to even out traffic at peak travel times. What with travel discounts and adapted timetabling, students are definitely well-served. Another element of appeal for the town.

WINNING THE FIGHT AGAINST SINGLE CAR OCCUPANCY

As part of the new travel plan, this re-designed transport network represents a solid basis on which to build behavioural change. The objective here is to restrict single car occupancy, the heart of Emmanuel Couet’s and his team’s combat: **“Just imagine, for 100 cars in rush-hour, only 103 people are transported.”**

However, if you listen to the Chairman of the Rennes Metropolitan area, the challenge is not insurmountable. Particularly with a car-pooling solution. **“If the people of Rennes car-shared just one day out of five, that would be the end of traffic congestion problems”**... and a huge advance in terms of less pollution.

To this end, the city is offering two new dedicated services. The first is a system which allows people to organise regular journeys like their commutes from home to work. **“We offer a mobile site for getting in touch in order to form car-sharing teams over the long term,”** explains Mylène Péridy. The second service responds to more occasional needs, on a city scale, like any other means of transport.



Restricting single car occupancy, is at the heart of Emmanuel Couet’s and his team’s strategy. To this end, the city is offering two new dedicated services of car-sharing.

This system of dynamic car-pooling developed by Keolis Rennes is available on the network’s new multimodal app, STAR. So an offer of car-sharing can come up at the same time with other travel routes provided in real time, or as an alternative to available transport networks.

“The driver who offers a journey is rewarded by voucher reductions valid in shops in the city. We are also thinking about an incentive system for the passenger. We will also encourage car-sharing with dedicated traffic routes and parking areas,” adds Mylène Péridy.

With these two tools, cost-free, car-sharing solutions are provided, both for long term and also on-the-move offers available to residents.

Riding on its ambitious innovation policy, in conjunction with the entire Rennes ecosystem, the Rennes Metroplitan Area has invented new ways of travelling together, whether it’s on public transport or with a car-pool. Emmanuel Couet is convinced, with the freeing-up of public space, innovation also generates a stimulating urban context which in turn encourages an improved quality of life. ●



Read the full version by Mylène Péridy, Rennes Metropolitan Area Transport Manager, on pulse-mag.com



Why are US Millennials switching modes?



The Millennials, those born between 1982 and 2003, have a different approach to mobility than previous generations. They make greater use of public transit as part of a multi-modal lifestyle. A survey by the American Public Transportation Association sought to understand their mindset.



by Jean-Pierre Montal
Illustration: Micaël

Doing things differently

Millennials in the USA are defying their upbringing by choosing public transit. The largest generation in America's history, are less likely than their parents to have grown up near convenient transit services and less likely to have travelled by themselves on public transit as children. In 2017, a mobility attitudes survey conducted for Transit Center found that just over a quarter (27%) of those aged under 30 had travelled by themselves on public transit as a child. By contrast, almost half (49%) of those aged over 60 had done so. This given is perhaps not surprising as only 38% of those aged under 30 said they had grown up in a neighbourhood that had convenient transit services. Yet, despite their sheltered, suburban upbringing, Millennials are more enthusiastic about transit than their parents, and more likely to ride it. In 'traditional cities', Transit Center's survey found that 43% of under 30s used transit at least once a week, compared to just 9% of over 60s. ●

A multi-modal lifestyle

Millennials are not wedded to any one transport mode. APTA conducted a survey of 1,000 Millennials in six American cities as part of a wider effort to understand their mindset. It found that more than two-thirds (69%) made journeys using multiple modes a few times a week, or more. They select the best transportation mode (driving, transit, cycling or walking) based on the trip they are planning to take. Communities that attract Millennials are ones that offer a variety of transportation choices, as demonstrated by Millennial "hotspots", popular neighbourhoods where residents have embraced a multi-modal lifestyle. APTA's survey found that ease of getting around was the most commonly cited reason (42%) among Millennials for choosing an area to live in, followed by proximity to work (38%), city culture (37%) and a range of public transit options (36%). In the past, starting a family was seen as requiring a shift to a car centric lifestyle. But while Millennials are more likely to own a car if they have children, they continue to embrace the multi-modal lifestyle. More than two-fifths (43%) of millennial parents told APTA that they use more than one transportation option for getting to a destination daily. ●

Connecting with communities

Public transportation allows Millennials to work as they travel, a trend noted by 39% of those polled by APTA. It is also seen as increasing engagement with communities in both the real and virtual worlds. More than a third (36%) have noticed themselves and/or others socialising more while travelling, with much of this taking place online. APTA found that 46% of Millennials cited getting more time to socialise (online, or via mobile) as one of the benefits of using buses. Outside of the virtual world, a third (33%) say that the way they travel enables them and/or others to make welcome discoveries in their area, and find hidden gems that they would not otherwise have known about. And more than a quarter (26%) say the way they travel makes them and/or others feel like a better member of the community. ●

The basics still matter

If you want to keep Millennials happy on public transit, keep them connected and make the most of this clear competitive advantage over the car. APTA found that more than half (54%) would like Wi-Fi or 3G/4G connectivity wherever they go within the next 10 years, and 45% would like a more connected or tech-friendly experience. And most (55%) would like to see more real time updates to help them avoid waiting longer than needed. But the perennial public transit basics of travel time, cost and reliability remain more important than "flashier" features like Wi-Fi. Cost and convenience are the main motivations behind millennial transportation choices (each are cited by 46% of respondents to the APTA survey). Looking to the future, more than three-fifths of Millennials would like transportation options that are more reliable (61%) and more affordable (62%). "My generation is strapped financially," said one respondent, "This makes [us] need to be a bit more creative in how we get around town." ●



THIS IS A MAJOR SHIFT

APTA's research has offered a fascinating insight into the pro-transit mindset of US Millennials. I think that younger Americans are becoming more global by the fact that they are showing signs of behaviour that are more traditional in European countries. And, while taking public transportation may not be a revolutionary idea in a different country, you have to understand that as Americans, life for a long time has been centred on personal ownership and driving freedom, so it is a major shift for so many younger people to say that they actually prefer something different. It's clear that this generation is very tech-savvy, and is open to new ideas and trends. The fact that it seems to be financially prudent gives transit an advantage over traditional vehicle ownership."

DARNELL GRISBY, American Public Transportation Association director of policy development and research



ROBOTS TO THE RESCUE!

Recent progress in artificial intelligence (AI) has paved the way for robotics to begin reshaping the transport sector. Today, robots are able to carry out an increasing number of routine and menial tasks. Here are five areas where robots are set to make a real difference.

With computing power approaching that of the human mind, robots are beginning to be used to interacting with customers. From mid-November to the end of 2017, a prototype manufactured by the Lyon-based Hease Robotics and tested by Keolis in an urban transport network in the city of Brest in western France is a prime example. Heasy, as it's known, approaches

SERVICES

customers waiting in line, making use of a touch screen to provide them with information on a number of things.

Heasy
Imagine a robot coming to help you out in a station. Instead of searching on the information panels, Heasy can give you all the information you need - routes, prices and timetables.



Robots able to park cars can make parking lots much more efficient, freeing up a lot of the space needed for vehicles to circulate. The largest automated parking system (APS) in Europe is in Aarhus (Denmark). It can park 1,000 cars using 20 lifts. In France, Stanley Robotics has developed Stan, an automated valet that parks all types of vehicles at the Charles-de-Gaulle airport in Paris.

AUTOMATED VALET PARKING

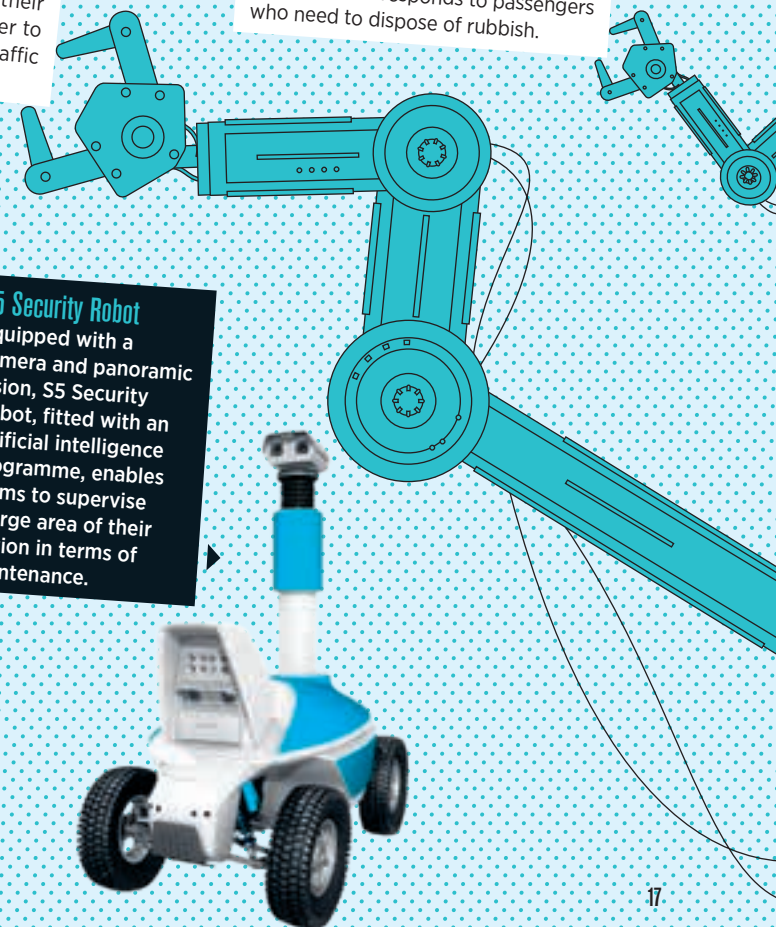


Baryl
Programmed with artificial intelligence, Baryl gradually learns to detect potential users who want to dispose of waste and to move towards them.

Robotic cleaners are a form of service robotics, a thriving niche market. There are two main categories. The first is widely used in the cleaning industry. For example, cleaning operatives may use a robot for more time-consuming tasks. The second is designed to meet much more specific requirements. One example is

CLEANING

an entirely automatic cleaner robot, designed by the French company Immersive Robotics. It has been tested for the first time in Europe by France's national rail company, SNCF, at Paris' Gare de Lyon train station. It avoids obstacles and responds to passengers who need to dispose of rubbish.



Robots can also be used to inform customers online. A French company, Bookbeo has developed conversational robots known as chatbots to aid transport users in the city of Bordeaux. These robots comb massive amounts of data to provide customers with specific information catered to their needs in real time. Users can interact with a robot via Twitter to find out about things like the closest bus stop, the state of traffic or possible routes.

CHATBOTS

Whether it's a large warehouse or a rail network, surveillance is key to ensuring a company's equipment and facilities are secured and in good working order. This can be done either by Unmanned Aerial Vehicles (UAVs, aka drones) or

SURVEILLANCE

Unmanned Ground Vehicles (UGVs). The S5 security robot manufactured by the US' SMP Robotics exemplifies the latter. It makes use of cameras, panoramic vision and artificial intelligence to survey large areas from a distance and transmits the information collected in real time.

S5 Security Robot
Equipped with a camera and panoramic vision, S5 Security Robot, fitted with an artificial intelligence programme, enables teams to supervise a large area of their station in terms of maintenance.

RIDING THE TREND

HOW BIKES ARE CHALLENGING THE MIGHTY AUTOMOBILE



Illustration: Jun Cen

The 20th century was in many ways the century of the automobile. Architects and urban planners reshaped entire cities, building all manner of bridges, tunnels, expressways, freeways and parkways to accommodate private vehicles.

But as cities have become increasingly congested and polluted, and the environment plus quality of life have taken on heightened importance over the past two decades, the humble bicycle has begun to make definite inroads into urban public transport.

PERFECT CONDITIONS

According to the consultancy Roland Berger, there were about 1,000 urban bike sharing schemes in 2016 worldwide, with more than 1.2 million bikes in cities.⁽¹⁾ What's more, the global market is expected to grow by 20% per year by 2020, reaching a total size of between 3.6 and 5.3 billion (€).

A number of factors lie behind the surge in the use of bicycles as a mode of transport in urban areas. For one, urbanisation has increased rapidly around the world in recent decades, with the UN estimating in 2007 that for the first time in history more than 50% of the world's population lived in urban areas. As a result, bikes are increasingly seen as a viable alternative to the polluting car in crowded urban spaces.

In addition to urbanisation, as digital technology has become widespread, people are now able to connect to vehicles and infrastructure in real time easily via their smartphones. Bikeshares across the globe today make common use of this technology. Not only can users rent using their smartphones, but transit authorities and

operators can manage flows and maintenance operations effectively.

“Beyond the spread of cities and the rise of digital technology, the past decade has seen the emergence of new consumer behaviour, where people are more comfortable with paying to share instead of owning. This is the so-called ‘sharing economy’”, explains Yann Rudermann, CEO of Cykleo, a Keolis subsidiary dedicated to active mobilities.

Local governments are in tune with all of this. And as they are looking to tackle pollution, environmental degradation and make cities more liveable, they have taken advantage of the new technology and consumer behaviour to foster the use of bicycles as an alternative mode of transport.

In short, the conditions are perfect for bicycles to proliferate in urban transit networks for many years to come.

FROM STRENGTH TO STRENGTH

Bike sharing systems have come a long way since their surprising origins in the famously bicycle-friendly Netherlands. In 1965, a group of Dutch anarchists decided to rattle the establishment and challenge the hegemony of automobiles on Amsterdam's narrow streets by painting bicycles white and leaving them unlocked in public for anyone to use. Needless to say, the “white bicycle plan”, as it was known, was quickly nipped in the bud by the police.

As a result of increasing urbanisation, bikes are increasingly seen as a viable alternative to the polluting car in crowded urban spaces.

Fast forward to Copenhagen in 1995, where a system with stations was developed. Customers would deposit coins to unlock bicycles. But bike sharing really began to show signs of promise a few years later in the city of Rennes in western France when US media company Clear Channel Communications developed a precursor to today's widespread schemes, paid for by advertising. Using information technology (IT) and docking stations, it allowed users to locate and access bicycles.

(1) Cabinet Roland Berger, “Bike Sharing 4.0”, June 2016, Hambourg.

Vienna was the next to give bike sharing its impetus, launching the Vienna bike system three years later in 2001. And though it had shortcomings it went on to enjoy significant success when it was rebranded and relaunched as Citybike Wien in 2003.

As self-service bike-sharing systems have spread, so has the use of personal bicycles as a means of urban transport. At the same time, electric bicycles have become an increasingly common sight on city roads.

The major breakthrough came in 2005, when the city of Lyon launched the first truly large-scale self-service bike rental scheme, using docking stations and IT and mainly paid for by advertising. This was followed two years later by Paris’ groundbreaking bike-sharing system, Vélib, which proved that such a scheme could be successfully used for daily transport in a large and dense metropolis.

“As self-service bike-sharing systems have spread, so has the use of personal bicycles as a means of urban transport. At the same time, electric bicycles have become an increasingly common sight on city roads, adds Yann Rudermann. Public authorities have caught on and here too are encouraging the use of this alternative to personal vehicles: Norway, Sweden and France have all decided to subsidise to varying degrees the purchase of electric bikes.”

DIFFERENT BIKESHARE MODELS

Today, there are currently three models for bike-sharing schemes. The pioneering and dominant one in Western cities is the self-service system with docking stations. Users can either pay for individual trips or purchase an annual subscription, unlocking a bike from one station and docking at a station near their destination.

These systems work well when there are a certain number of users, and when transport

Bordeaux, France

Since it was launched in 2010 at TCL (now TBM), a network operated by Keolis, the V3 scheme has been wildly successful. With 1,750 bikes and 175 self-service stations, some 7,500 bikes are used on average per day. There are 17,000 subscribers and close to half a million occasional users per year. Before V3 was put in place bikes accounted for a mere 4% of mass transit. In seven years the percentage has more than doubled, making Bordeaux the sixth most bicycle-friendly city in the world. The city is now aiming to bring bicycles’ modal share up to 15% by 2020 by continuing to extend and densify the V3 network each year.



Hangzhou, China

With 66,500 bicycles and 2,700 docking stations as of 2013, not only is Hangzhou Public Bicycle China’s first bikeshare, it is also the world’s largest. Launched in 2008, it now plans to expand to 175,000 bikes by 2020. The system uses smart-card technology and provides real-time information to track bikes in use and ensure user demand is met adequately by the stations. The system is designed so bikes feed into the city’s public transit network, capitalising on the concept of the last mile.



Montreal, Canada

BIXI Montréal was launched in 2009 and was North America’s first large-scale bike-sharing system. It is run as a non-profit organisation, created by the city government. Like with many other bikeshares, each station has a kiosk where users can pay.



authorities work in close partnership with operators, sharing work and costs. The bikes obviously have to be maintained and flows have to be regulated to a certain extent.

These are anchored in the cityscape, providing a reliable means of transport in the form of sturdy bikes, which are often high-end. They can be electrically assisted, make use of GPS and even have vibrating handlebars. What’s more, the bikeshares make use of cleaner technologies such as solar power for the docking posts and information kiosks. There are now hundreds of these systems around the world.

The other model competing for users in urban areas is the dockless bikeshare (the so-called free-floating system), which was developed in China and has spread throughout Europe and North America. The scheme consists of bicycles equipped with GPS trackers and digital locks. Users simply download an app on their smart-phone and use it to locate and unlock a nearby bike. They then ride it to their destination and simply leave it wherever they choose.

Free-floating schemes have been hugely popular in China. Despite their success they do, however, have several drawbacks.

The free-floating schemes have been hugely popular in China, and their clear advantage for transit authorities is the lack of investment and infrastructure needed in getting them up and running. But make no mistake...

“Despite their success in Asia and apparent ingenuity, they do, however, have several drawbacks, warns Rudermann. The quality of the bikes, for one, tends to be lacking. They cost about seven to eight times less than bikes used in self-service dock schemes, which means they are particularly susceptible to mechanical failures and vandalism. Added to this is the lack of maintenance due to the business model, which tends to focus more on short-term profitability. There is consequently the problem of locating a bike only to find it is broken. This has resulted in highly non-sustainable practices in China, for example, with thousands of used bikes ending up literally dumped in fields.”



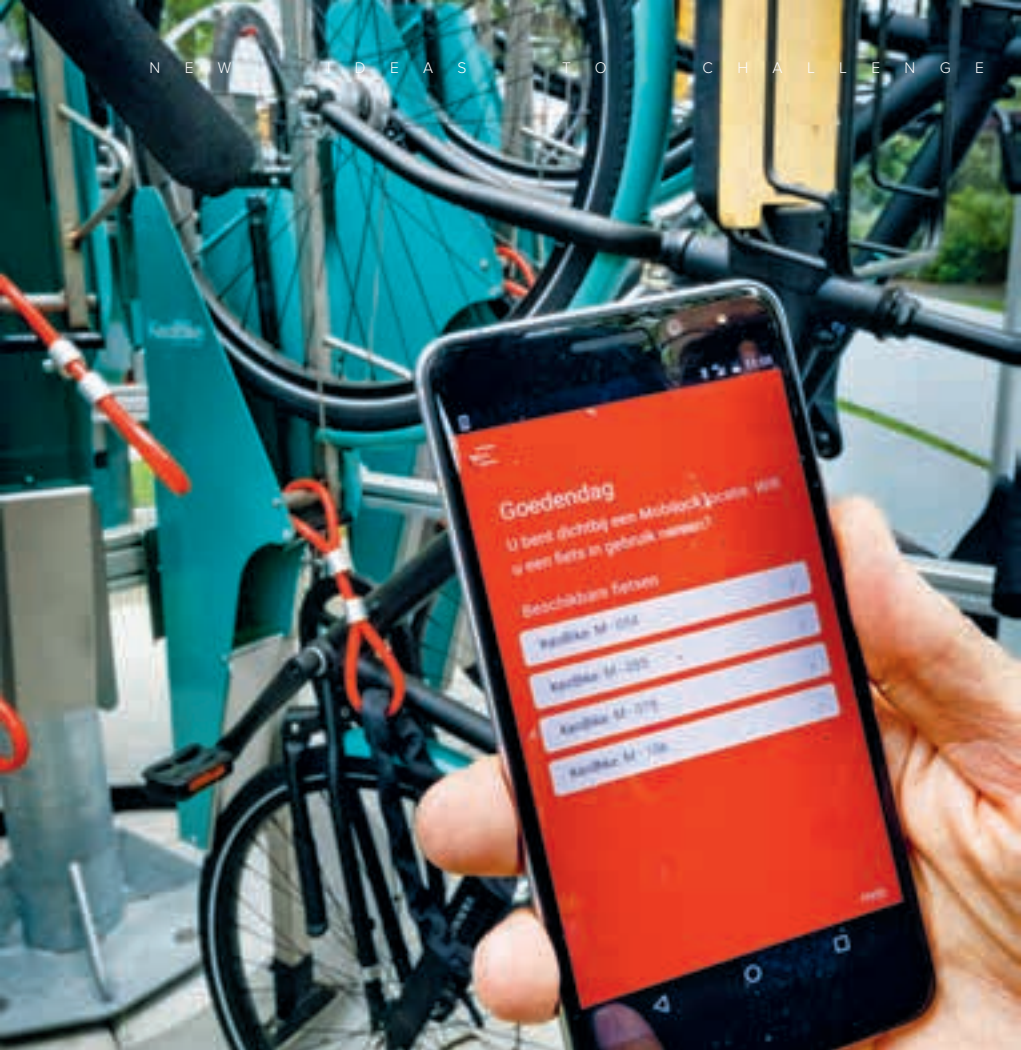
The third model consists of long-term bike rental for use in suburban areas, where there is a lack of urban density to make a bikeshare practical and profitable – i.e. docking stations need to be separated by relatively short distances. It targets users who are looking for a quality bicycle to use over longer periods of time but aren't willing to purchase one. The advantage is the user has an affordable option – which they can pay for on a monthly basis, for example – and they don't have to commit in the long term. What's more, employers and authorities can subsidise such rentals, much more easily than the purchase of a personal bicycle. There is also an operator available to service and maintain the bike when needed.

INTEGRATING SEAMLESSLY

One thing is having thousands of bicycles available for use on the streets, another is making sure they are fully integrated into the network as a real shared transport mode. Public transport authorities have a large role to play in fostering this by instituting local policies that link the use of bicycles to urban transit.

Public transport authorities have a large role to play in making sure bicycles are fully integrated into networks as a real shared transport mode, by instituting local policies that link the use of bicycles to urban transit.

“The full integration of bikes in the transport network is key to guaranteeing the efficiency and attractiveness of the whole network, explains Rudermann. Indeed, public transportation must be thought of in its entirety, from door to door, regardless of the reason and mode of transport. While mass transit remains vital to conveying people in urban areas, it is



◀ **The Netherlands**
Keobike is a bikeshare launched in 2016 in the Netherlands. A total of 360 bikes are available in 31 locations in the east and center of the country and can be hired using a smartphone. An extra 208 bikes will be available before 1 August 2018 and 24 new locations (total of 55 locations). Keobike is thus fast growing in the Netherlands. The bikes hang on carousels, which are equipped with solar panels on the roof to generate the power to rotate the bikes when they are needed. The application can be used to reserve and unlock a bike and makes use of an I-beacon to monitor the bike and its location at all times.

increasingly complemented by flexible and ‘softer’ modes, such as autonomous shuttles and bicycles. These modes are better suited to the so-called last mile – i.e. from the transport hub to the final destination.”

This includes measures like creating bike lanes, putting in place parking spaces and bike shelters, multi-modal information and signage, joint ticketing, combined fares and joint mobility applications that cover bike stations, paths and parking options along routes. In short, what authorities did for the personal automobile in the postwar decades, arguably, must be done for bicycles.

The French city of Dijon offers an example of how bicycles can become part and parcel of an urban transport network. For the first time in France, this city has recently signed a comprehensive mobility contract with Keolis to operate its public transport, car parks and short- and long-term bike rentals (400 short-term and 800 long-term rental bikes at 40 different stations). The idea is to eliminate the frequent debate between individual transport and public transport, by promoting the shared use of public space.

Full integration of bikes in the city landscape has to be considered alongside the question of security. Cyclists must be able to coexist with both vehicles and pedestrians. The number of cyclists being fatally injured on the roads in the US continues to be of concern. Bikes are a special case as they can access spaces reserved for vehicles and pedestrian areas. For this to work smoothly, besides creating bike lanes and making them safe, cyclists themselves must be educated so as to allow them to integrate seamlessly in urban traffic, be it motorised or not. This raises the question of a bike license to help usher in the transition to complete acceptance of bicycles as a full-fledged and integral part of mass transit.

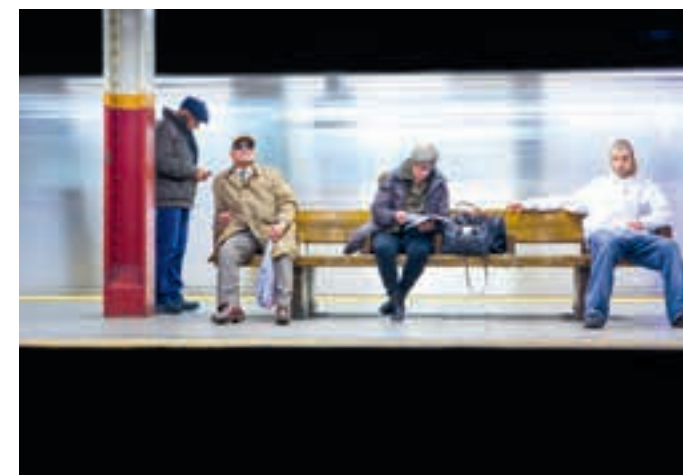
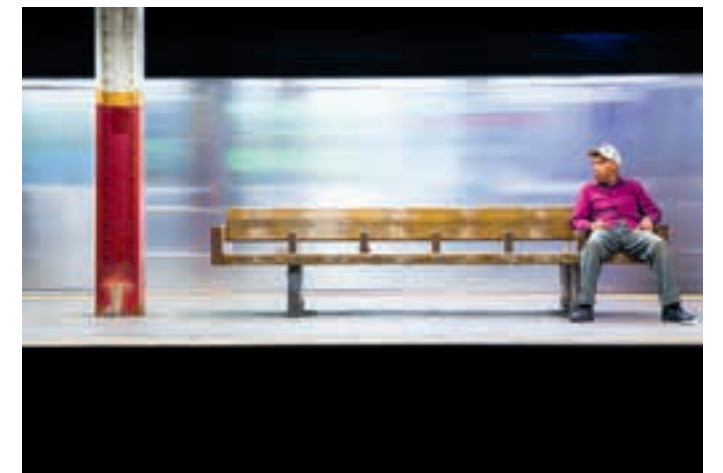
Denmark is an example of a country that has achieved progress in this area. By investing heavily in cycling infrastructure in Copenhagen, for instance, bicycle traffic has risen by no less than 68% in the past two decades, however the number of accidents remains small, allowing cycling to become a normal part of city life.

Cyclists must be able to coexist with both vehicles and pedestrians. Besides the creation of bike lanes, cyclists themselves must be educated so as to allow them to integrate seamlessly in urban traffic, be it motorised or not.

The road has certainly been long, and the competition in the form of the automobile has been stiff. Yet despite the bumps and hurdles along the way, there is no turning back: bicycles as a mode of urban mobility are very much a part of city life in the 21st century. The question is how to fully anchor, extend and secure their use. But if the success of bike-shares across the world over the past decade is anything to go by, the humble bicycle has already won the race. ●

CAPTURED LIVE

Public transport routes are like water channels criss-crossing cities, irrigating their different districts. Each line tells, in its own way, the chapter of a bigger story. Inspirational stuff for artists and photographers in particular, always on the look out to get a unique shot. Situations, faces and moods brought together by urban transport. Realist, dream-like, funny and sometimes moving... discover in the following pages the many facets of New York, London and Singapore. Three cities revealed by their transport systems.



RENNY WHITEHEAD, NEW YORK, USA

"Given that this most famous of cities is also probably one of the world's most photographed, I wanted to find my own way of telling a New York story. I came up with the idea of using the subway system with its grime, attitude and everyday hustle. It's the beating heart of an incredibly diverse city so I thought it would be the perfect place to capture something truly representative of New York."

www.newclearphotography.com



EDWIN KOO, SINGAPORE

"Transit is a work about the strange phenomenon of daily displacement. Traveller's feelings are always concealed, except for that split second before the doors close, when they are confronted with an absolute stranger who is in the process of revealing their true inner feelings, forever in a still image. Transit became a game for me. One that creates a collective portrait of modern commuters. Of course, the photos are all random, just like the idea of meeting someone on a train being a random moment in time."

www.edwinkoo.com



NICK TURPIN, LONDON

"While waiting for a friend outside a cafe in the winter I noticed how beautiful the illuminated windows of the passing busses were and how the rain and condensation made them look so painterly. That moment started a three year long project. I spent many cold and wet hours watching people in London's double decker buses, making me feel like a wildlife photographer watching the behaviour of a species in their natural habitat."

nickturpin.com

HOW CAN WE MAKE TRANSPORT ACCESSIBLE TO EVERY-ONE?

Visible or invisible disabilities, impairments, health problems, illiteracy... we are not all equal when it comes to mobility. Here, we take a look at some initiatives which make mobility more inclusive, in response to four major human vulnerabilities researched in the context of the Keoscopie Observatory of habits and lifestyles.

by Jean-Pierre Montal

1 APPS FOR HELPING DISABLED PEOPLE GET AROUND

In France, **12 million** people suffer from a disability⁽¹⁾. The Disability law stipulates that public transport must be 100% accessible to people with reduced mobility in 2018 (in 2021 for interurban connections and 2027 for all rail traffic)⁽²⁾.

European law states that they should have “generalised accessibility” to transport. Apart from adapting rolling stock to their needs, the sharing of information represents a key lever in providing disabled people with access to transport.

The **Iwheelshare** application provides an interactive and evolving map that details all the places – and not just transport modes – that are easy to access in a wheelchair. The users are able to make additions to the map on a daily basis. Another example is **Audiospot**, an app for blind people. This application localises the user and announces useful information during their journey, for example, the nearest bus stop, the relevant bus routes and arrival time of the next bus.



(1) Source: Keoscopie.
(2) Source: AFP, March 17, 2017.

2 EDUCATION TO REDUCE DIGITAL VULNERABILITY



Increased mobility also comes from a better understanding of existing services, particularly digital tools. This is a critical issue, not just for older citizens who are often disoriented by the general digitalisation of society, but also for people who cannot afford to buy a smartphone.

The **Greater Bordeaux** area opted for a “mobility platform” launched by Keolis in partnership with **Wimoov** (see insert right page). It’s a network of helplines established in the 28 municipalities of the area which are manned by mobility advisors. Their tasks are to help passengers get to know the network, tell them about new mobility solutions adapted to their needs and educate them to use digital tools associated with transport (ticketing, searching for travel routes...). Some 80% of older citizens benefited from the service and now travel regularly and feel more at ease with their transport usage.

3 BUSES FOR HELPING THOSE WHO SUFFER FROM ALZHEIMER'S

Degenerative dementia (of which Alzheimer's represents between 60 to 70% of all cases) affects 47.5 million people all over the world with nearly 10 million new cases every year⁽²⁾.



In general during the first stages of the illness, depending on the case, people are still able to use public transport thus maintaining their independence and not becoming isolated. The **United Kingdom** decided to tackle this public health issue head on. More than 200 councils have been awarded a “dementia friendly” label. Specific adaptations have been made to buses for the illness that affects people's attention span with enhanced comprehension for announcements and significantly increased visibility for signage. The programme goes further by consulting people suffering from dementia to help adapt bus interiors and training drivers and conductors to welcome sufferers of the illness on board.

(2) Source: World Health Organization (WHO).

4 ADAPTED SIGNAGE FOR ILLITERATE PEOPLE

It is known that 14% of the total world population (approx., 750 million people) cannot read, write or have difficulty with both of these activities⁽³⁾. In **Melbourne**, bus stations have been numbered or re-named with a very simple, factual word linked to the surrounding urban environment (a specific monument recognisable by everybody, for example). The underground map thus becomes more obvious and easier for everyone to understand. Another initiative was introduced in **Mexico**, where illiteracy is estimated to affect 10% of the population. In order to encourage mobility, the Mexican Municipal Transport Service appealed to the famous American graphic designer, Lance Wyman, to devise a signage system completely based on icons (symbolizing well-known monuments) and pictograms (designating station connections, exits, information desks...). This system was introduced back in 1969 and has expanded with the city's underground. Mexico is a more legible and accessible city.

(3) Source: Unesco.

VIEWPOINT

“Mobility, you have to learn it!”

FLORENCE GILBERT,
Managing Director of Wimoov and Chairwoman
of the Inclusive Mobility Laboratory



“In many countries and particularly in France, transport systems have been designed according to a model of ‘mass transit’, enabling the majority to move around. Despite this global approach, the system excludes those who are disabled, have financial difficulties or who quite simply have atypical working hours. The subject of inclusive mobility, mobility that is accessible to all, has been active in French public debate since 2013. It is a major challenge given that transport difficulties represent the second obstacle to a return to employment in France. It is therefore essential to involve vulnerable passengers in the conception of networks or new services as is the case, for example, in Copenhagen. Another necessity is passenger education. Whether we're talking about easier understanding of transport maps and signage, or better knowledge of the transport solutions proposed or furthermore the use of new digital tools, you have to learn about mobility. This is the firm belief we are defending with the installation of mobility platforms in stations and directly approaching people who feel vulnerable in a mobility situation, to help them. Our objectives are to dispel the myths that transport is difficult and encourage passenger confidence.”

INTERVIEW



“FREE TRANSPORT IS OFTEN THE SHORT-CUT OR SHORT-TERM OPTION”

Germany recently made the headlines when it announced its intention to introduce free public transport in five major cities.

Yves Crozet reacts with firm conviction to the project which he believes is often linked to electoral promises. In his opinion, if free transport remains an isolated measure without restrictive policies on the use of private cars, it has no impact.



by Ingrid Labuzan

Yves CROZET

Yves CROZET is an economist, professor emeritus at the University of Lyon (IEP) and research fellow at the CERRE (Centre on Regulation in Europe - Brussels). From 1997 to 2007, he was director of the Laboratory of Transport Economy (LET). He is chairman of the French Road Union think tank and is a board member of the French National Highway System. He is mayor of Saint-Germain-la-Montagne in France, Loire department.

.....

WE

HEAR A LOT ABOUT THE SUBJECT OF FREE TRANSPORT. IS IT A REALISTIC PROJECT?

Y. C.: In France, 36 towns have decided to propose partially or totally free public transport. As an example, Niort is the second region of more than 100,000 residents following Aubagne, to propose totally free transport. Other towns concerned are smaller, with a population of under 50,000 people. In these smaller size towns, free transport is due to practical and economic considerations. Users of public transport are not extensive and the ticket cost is low. Profit

margins do not account for a large part of transport costs which are financed by taxation and private companies. In this instance, offering a free service is sometimes easier and less expensive than managing a ticketing and gating system.

Free transport is often presented as a panacea to all problems of mobility.

Users of public transport have no other choice since private car use remains the overriding motorised form of transport.

The problem occurs when we transpose the idea of free transport to large regions. In such cases it is presented as a panacea to all problems of urban mobility (pollution, congestion, mobility as a civic right...), when in reality it only makes full sense when it is part of a more global policy that aims to reduce the use of private cars by tolls, dissuasive parking costs, and restrictive measures for polluting vehicles. Without these measures, free transport is surely a popularity-seeking measure.

THEREFORE

DO YOU CONSIDER THAT FREE TRANSPORT ALWAYS HAS A COST?

Y. C.: Free transport presented as “the panacea” is often a short-cut or short-term option. How indeed can we finance the daily use and maintenance of a transport system on a not for profit basis?

In small towns, and also medium-sized ones, the networks are not large and are often based on a small circuit of bus or coach routes. They use the existing highways and are not very costly. Based on what I was able to observe during my time as mayor of a small town, local authorities often have the necessary budgets to finance a policy of free transport. The capital necessary for the functioning of a network can thus come from their budget allocations, rates and taxes or also from public borrowing.

On the other hand, in large-scale regions, the cost of transport networks is high, in particular for underground or tram services. These towns do not have the budgets required for financing the introduction of free transport and guaranteeing a good long-term, quality service.

The economic viability of free transport therefore depends greatly on the size of the town and the extent of free pricing.

We should also point out that some free transport systems are no more than a facade as in reality they are truly financed by passengers. That’s the case for example in the tourist town of Chamonix, a major French winter sports resort. The shuttles used for

The economic viability of free transport therefore depends greatly on the size of the town and the extent of free pricing.





▲ Portland:

The “Fareless Square” was introduced in 1975. This zone of 3.5 km² was at that time totally free. The city got rid of the system in 2013 due to fraud, once passengers had crossed out of the free zone.

transporting passengers to the ski runs are free of charge, but their cost is passed on in the price of the ski lift passes.

IN THE LONG RUN, DOES FREE TRANSPORT BRING ABOUT OTHER RISKS OR PROBLEMS?

Y. C.: If we are discussing free transport, we need to be honest about explaining how it will be financed. And one of the probable responses is an increase in taxation. We then have to determine the extent of the increase and where the burden falls, is it on households or businesses? An alternative possibility would be raising local public borrowing. Both these solutions have significant consequences for regions.

Furthermore, free transport may also run the risk of public transport services being misused; greater use by some parts of the population for example to the detriment of regular passengers, with the additional risk of damage and hooliganism...

It is important to consider the image free transport conjures up. Non-payment has a psychological effect, it induces an absence of value for the passenger. Providing free transport could encourage citizens to take it for granted



Tallinn:

The Estonian capital ran a free transport system trial in 2013 before completely abandoning it due to an increase in poor social behaviour.

and even to misuse the service, if we push our reasoning to the extreme. Pricing gives the passenger a sense of responsibility and gives value and credibility to public transport.

CAN THE IMPACT OF FREE TRANSPORT BE POSITIVE FOR THE FUTURE OF TRANSIT SYSTEMS?

Y. C.: With free transport comes the question of financing infrastructure, particularly in large regions. Developing new networks is very expensive. If we take the example of the Ile de France region, Ile de France Mobilités (formerly STIF), borrowed 1 billion (€) a little over two years ago. In the next ten years, current projects will increase this borrowing to 9 billion (€), not including investment in the Grand-Paris-Express. How can such an amount be repaid without passing on some part of this to the passenger?

Let me give you another example, there is a project for a new underground line out to the west of the Lyon Metropole. Research shows that such a project would require investment of several hundred million euros. In this context how can we even envisage free transport?

It is therefore hard to imagine how we could manage without passengers’ contributions when large regions today face the challenge of maintaining,

renovating and developing their transport infrastructure and services. These cities must be able to respond to passengers’ current requirements, the evolution of technology, and the growth of their populations and regions they inhabit.

■
Providing free transport could encourage citizens to take it for granted and even to misuse the service.
■

IN FRANCE THE MAJORITY OF FREE TRAVEL EXPERIENCES HAVE BEEN CARRIED OUT IN SMALL TOWNS, IS THIS ALSO THE CASE INTERNATIONALLY?

Y. C.: Several of the cases experienced in other countries have been in large cities, occasionally on the scale of the entire city, others have been on a smaller scale.

Tallinn, the capital of Estonia decided to introduce free transport across the city. They have a population of 400,000.

Portland, an American city of over 600,000 inhabitants introduced a travel-free zone, only in the centre of the city.

In several European, Canadian or American cities, free travel exists in some zones of the hyper-centres or serving particular areas (universities, shopping malls).

WHY HAVE SOME OF THESE INITIATIVES BEEN ABANDONED?

Y. C.: If we take the example of Portland, free travel was restricted to a zone of 3 km² in the city centre but passengers took advantage of this and continued their journey beyond the free zone. In Tallinn on the other hand, they are continuing with the policy but it is restricted to city residents, they are only 400,000 after all. Costs are passed on in local taxes.

■
Whatever the system envisaged, it is important in my opinion to maintain the act of validating a travel ticket so as not to devalue the service provided, even if the individual benefits from an advantageous price.
■

COULD AN ALTERNATIVE TO FREE TRANSPORT BE PROGRESSIVE AND HAVE DIFFERENT PRICING DEPENDING ON PASSENGER PROFILES?

Y. C.: This does already exist in some cities and represents an interesting path of investigation. Pricing differentiation is

generally means-related or status-dependent (students, unemployed), based on age or number of persons in a household. The system works on the principle of reduced fares but we could also imagine a system where prices are increased for those with the highest incomes and thus support the upgrading of the transport system.

There may be other criteria that make sense, for example major tourist cities could introduce higher costs for tourists than for residents. Whatever the system envisaged, it is important in my opinion to maintain the act of validating a travel ticket so as not to devalue the service provided, even if the individual benefits from an advantageous price.

IN YOUR OPINION, WHAT WOULD BE THE IDEAL PRICING SYSTEM?

Y. C.: As an economist, I would recommend a pricing system based on the distance travelled, as is the case in several cities such as Washington or Singapore.

■
There is no ideal transport pricing system without parallel restrictive policies in relation to car use.
■

During the rush-hour in the centre of Lyon,

between Bellecour and Cordeliers, 25% of passengers only travel one underground station on line A. This costs them nothing as they have a travel pass. Pricing based on distance would enable us to reduce congestion on the network and encourage walking, which also has a role to play within public health.

But above all, it is my strong conviction that there is no ideal transport pricing system without parallel restrictive policies in relation to car use.

WOULD TAXING CAR USE IN THE CITY BE A SOLUTION TO FINANCING PUBLIC TRANSPORT?

Y. C.: For city councils motorised mobility has a significant monetary and environmental cost (highway maintenance, signage...). However, in France car use is practically free in towns. It is essential to create restrictions on car use, like for example, urban tolls, licencing systems, expensive parking. This revenue could then be used to finance more efficient and less costly transport systems for passengers.

All too often transport and highway policies are led independently, one could even say in a contradictory manner. Only a global approach will result in a modal shift of car drivers to shared transport. ●



▲ Lyon:

With 4 metro lines, 2 cable-car lines, 5 tram lines and more than 120 bus routes, servicing more than 3,000 stops, the Lyon network welcomes 1.7 million passengers on board every day and enjoys the best ratio of revenue/cost in terms of public transport in France.

Washington:

Public transport costs are based on the distance travelled and time of day of use. The day of the week, also have the time and the length of journey have an impact on ticket price.



T H E POWER O F ELECTROMOBILITY

Electric buses hold the potential to spark a modal shift away from personal automobiles in cities and towns across the globe, lending them great promise in reshaping mass transit in our increasingly urbanised world.

by Richard Venturi

At the end of October 2017, the UN's World Meteorological Organisation (WMO) released figures that showed that the concentration of atmospheric CO₂ had reached 403.3 parts per million in 2016, a level not seen since the Pliocene age some 3 million years ago, when sea levels were 25 meters higher than today⁽¹⁾.

Given this and given the 2015 Paris Agreement's ambitious goal of keeping global warming well within 2°C by 2100, the push to green the economy by developing alternative energy sources is now well underway.

The transport industry has a pivotal role to play in this. According to the EU, the sector, which includes cars, trucks, aviation and international shipping, contributed just under 26% of total GHG (greenhouse gas) emissions of the 28 member countries⁽²⁾. And when it comes to cities, buses are at the heart of the way mass transit is being made more sustainable.

While buses represent only a small fraction of the pollution stemming from transport, their electrification can be particularly effective in reducing emissions and noise pollution in dense urban areas, both of which are growing rapidly across the globe. And unlike rail systems – be they trams, metros or commuter trains – buses require relatively little in the way of infrastructure, meaning networks can be up and running quickly.

(1) WMO (2017), "The State of Greenhouse Gases in the Atmosphere Based on Global Observations through 2016", *WMO Greenhouse Gas Bulletin*, October.

(2) European Environment Agency (2017), "Greenhouse gas emissions from transport", Indicator Assessment.

ON THE VERGE OF ELECTRIFICATION

China exemplifies this well. More than 350,000 electric buses are already in service in the country, and the south-eastern city of Shenzhen has become the first city in the world to go completely electric, with more than 16,000 buses on the streets.

In the West, Northern Europe has led the way in the use of biofuels for mass transit – with Sweden being the pioneer – and is now moving towards electric buses, with the rest of Europe and North America now following in its path.

This trend is likely to intensify for several reasons. One, public opinion, the media and politicians are pushing industry to follow through on the energy transition. Two, battery technology is advancing rapidly, making electric buses more and more economically viable.

A third reason is down to the actual supply of battery-electric buses (BEBs). Manufacturers have developed their offer of electric buses extensively over the last two years. BYD and Volvo are just two examples of auto manufacturers banking on BEBs, with both unveiling new models in 2017.

Volkswagen is also onboard, announcing last year it will invest 1.4 billion (€) in developing electric trucks and buses.

While buses represent only a small fraction of the pollution stemming from transport, their electrification can be particularly effective in reducing emissions and noise pollution.

The fourth driver is industry standards. The European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC) and other bodies such as the International Organization for Standardization (ISO) are working to develop European and international standards with respect to charging, which are set to come in place over the next two years.

This will level the playing field for manufacturers and operators and further spur market growth.

The Gothenburg Västtrafik network (Sweden) uses renewable energies to power 65% of its 390,000 passenger-kilometres covered every day (see Pulse #1).





Los Angeles – In 2010, the Foothill Transit network in the suburbs of Los Angeles, was the first American network to start using a fast-charging electric bus (see following page).

On top of all of this, more and more cities are lining up to transition their bus fleets to BEBs. In October 2017, within the frame of C40 (Cities Climate Leadership Group) mayors from a dozen global cities, including London, Paris, Los Angeles and Mexico City, signed the Fossil-Fuel-Free Streets Declaration, pledging to procure zero-emission buses from 2025 and “ensure a major area of (their cities are) zero emission by 2030”.

TOWARDS A VIABLE FUTURE

For the time being, BEBs cost twice as much as diesel buses. In effect, the excess expense today comes from the high prices of batteries – whether it’s the initial investment or the cost of replacing them (although public transport operators can usually benefit from rental opportunities from manufacturers, if buying the batteries proves too costly). However, prices of batteries have plummeted up to 90% in the last decade and are expected to continue to fall, with projections indicating BEBs will become commercially viable between 2020 and 2025⁽¹⁾.

(1) Hoyos Guerrero A. (March 4, 2017), “Are hybrid and electric buses viable just yet?”, World Bank Transport for Development blog, <https://blogs.worldbank.org/transport/are-hybrid-and-electric-buses-viable-just-yet>.

Though urban bus fleets have yet to be replaced by electric buses, it is important transit authorities adopt a transition period and carry out trials. This will help ensure the energy transition is being carried out in line with the different environmental guidelines and targets. It will also enable authorities to take into account the local expectations, contexts and challenges by creating models and evaluating the technical and economic impacts. Moreover, this approach will enable operators to provide the best possible quality and deliver the optimum cost in the long run.

Recharging the batteries efficiently is the key to running successful trials. There are two ways this can be achieved. The first is charging along the line. This is done by fast charge, i.e. when the bus stops, a pantographic system connects to an overhead fast-charger for a few seconds to a few minutes. This provides a large enough charge for the vehicle to continue until the next charge. This can either be at every station, every few stations or at the end of the line. Helsinki, Finland, currently has several fast-charging BEBs in service.

The second charging solution takes place by plugging during 6 to 8 hours, when the bus is at the depot. For BEBs, this consists of an overnight charge.

Of course, the type of solution opted for depends on factors such as the topology of the route, the distance between stops, climatic conditions, time spent at stops and the number of passengers.

INTEGRATING ECO-BUSES INTO A GLOBAL URBAN POLICY

Replacing fleets of diesel buses will certainly help unclog congested cities by reducing GHG emissions as well as fine particules and nitric oxide. But their ability to drive down emissions is much greater when the whole system is taken into account. In other words, quiet cutting-edge BEBs can very likely foster a modal shift, getting people to leave their personal vehicles at home. And this is where the significant impact will be.

According to calculations by the World Bank, if buses carrying 150,000 passengers per day on a simulated 30-km transit corridor were to shift to 100% electric, annual emissions would be cut by 27%. However, if 10% of passengers have made a modal shift – i.e. they leave their cars at home – this would be equal to a full 48% drop in emissions.

China clearly appears to be leading the way when it comes to this shift. As mentioned before, the city of Shenzhen is a case in point, with its more than 16,000 fully-electric buses.

Taking the long view, the transition to alternative energies in transport is more than simply a change in motorisation – it’s the emergence of a new mode of transport, which poses numerous interconnected challenges.

Despite these challenges, electromobility is here to stay and electric buses are without a doubt a driver for bringing more sustainable transport to urban areas around the world. In short, they are certain to reshape both how we perceive and experience public transport across the urbanising world of the 21st century. ●

CLEAN AIR PIONEER

A leader in sustainable mobility, California's Foothill Transit has set a goal to convert its entire 360-bus fleet to electric by 2030. We discuss with Deputy Executive Director, Kevin Parks McDonald about Foothill's operations and ambition.



Kevin PARKS MCDONALD

is the Deputy Executive Director of Foothill Transit. As such, he leads the network's day-to-day operations. In particular, he is responsible of the oversight of the Procurement, Capital Facilities, Human Resources, Customer Service and Operations, Maintenance and Vehicle Technology, Planning, Safety and Security, Information Technology and Finance functions.

“Foothill, a network operated by Keolis Transit America since 2017, has always had a pioneering spirit. In 2010, we became the first transit agency in the United States to bring a fast-charge electric bus into service. In 2014, our Line 291 became the country's first bus line operating exclusively electric buses.

In 2017, the American Public Transit Association awarded its Platinum Level designation for significant sustainability accomplishments to Foothill Transit, the first time this level had been attained by a bus-only public transit system.

Our decision to have an 100%-electric bus fleet by 2030 was therefore a natural continuation of our commitment to pushing the envelope. It also reflects the spirit of our ambition to be the premier public transit provider committed to safety, courtesy, quality, responsiveness, efficiency and innovation.

The benefits of electric buses for people and the environment are clear. They reduce emissions of harmful chemicals into the air, providing a major public health benefit. Cleaner air increases life expectancy and protects vulnerable populations like children and the elderly who are most susceptible to lung and heart disease. It also helps to restore balance to the ecosystem and contributes to the fight against global climate change. Electric

buses also run quieter than a normal conversation, reducing noise pollution and improving quality of life. And our all-electric buses require no oil change, have lower maintenance costs and save on fuel costs.

The conversion program builds on the experience gained through a demonstration project begun in 2010 in which we ran three electric buses for three years on one of our most demanding routes. This enabled us to evaluate the battery electric bus technology to ensure that it could meet the service requirements.

Following the successful demonstration, Foothill ordered 12 next-generation fast charge buses, which began operating in 2014. This enabled us to fully electrify one route in our service area – Line 291 – and investigate the feasibility of the technology for other routes. Based on this positive experience, our board made the decision to go all-electric by 2030.

Our decision to have an 100%-electric bus fleet by 2030 was a natural continuation of our commitment to pushing the envelope.

Since we announced our decision in 2016, we have been moving forward with our partners: the utility company that supplies the power to charge the buses and the electric bus manufacturers who supply the infrastructure to keep our fleet moving. We also work with our bus operators to train their teams on operating and maintaining electric buses.

Currently, we are working on solutions to an array of challenges. These include finding ways to control electricity costs and putting in place the necessary infrastructure for overnight charging, in order to support operations on long commuter routes.

Since our announcement, other transit authorities have undertaken similar commitments, including the Los Angeles Metro Authority. We are pleased to share our experience and have hosted visiting government and transit officials from this country and around the world.

We communicate our progress regularly with stakeholders at community engagement events, on our website and via ads in local publications. Regional stakeholders, bus operators and mechanics, and both customers and non-riders have applauded our move to all-electric and look forward to the positive impacts it will have for our local communities and the environment.” ●

FOOTHILL TRANSIT QUICK FACTS

LARGEST MUNICIPAL OPERATOR
in Los Angeles County

14 MILLION
riders per year

361 BUSES
in service (344 CNG and 17 fast-charge electric)

147 BUSES
operated by Keolis
of which 14 are electric

WHAT ALTERNATIVES TO CONVENTIONAL FUELS?

After many years of popularity, diesel is today at the heart of the debate on environmental challenges and public health. Responsible for CO₂ emissions, the fuel is a major contributor to global warming. It pollutes on a local level, releasing nitrogen oxide and fine particulates, both of which are harmful. Its use maintains our dependence on fossil fuels. And finally, it is also the cause of a more insidious pollution, that is noise pollution. According to the World Health Organisation, traffic noise may be a cause for some serious mental illnesses. That is why it is crucial to limit the use of fossil fuels and diesel, in particular. This challenge is supported by the continued development of environmental norms that impose emission ceilings across the world (Euro VI in Europe for instance) and encourage the development of diesel alternatives.

Among the current solutions, the most obvious is **alternative fuel**. HVO (Hydrotreated Vegetable Oils, hydrocarbon manufactured by the hydrogenation of vegetable oils) is a direct substitute for diesel. Natural gas, once compressed, can also be used as fuel (GNC). The use of **hybrid engines** (combustion engine and electric motor) drastically reduces fuel consumption and thus the emission of pollutants.

Finally the most radical solution is **100% electrical mobility**, made possible with **embedded batteries**. Buses using fuel cells are also being developed. Hydrogen generating electricity power the vehicle's electric engines.

As Jean-Marc Ducros, Director of Alternative Energies at Keolis, reminds us: "There is no ideal solution, there are case by case solutions which take into account the operating constraints and budget requirements of each network (topography, climate, use...). The energy transition cannot take place without major technological breakaways and there are a multitude of technical solutions available on the market right now that enable us to move away from our diesel dependency."



STOCKHOLM, SWEDEN

Since 2015, Stockholm has been renewing its fleet with the ultimate aim of using only 100% hybrid buses. As part of the European project ZEUS – Zero emission Bus Urban System – the project was initiated with eight 12 metre hybrid buses. These buses cut diesel consumption by 30%.



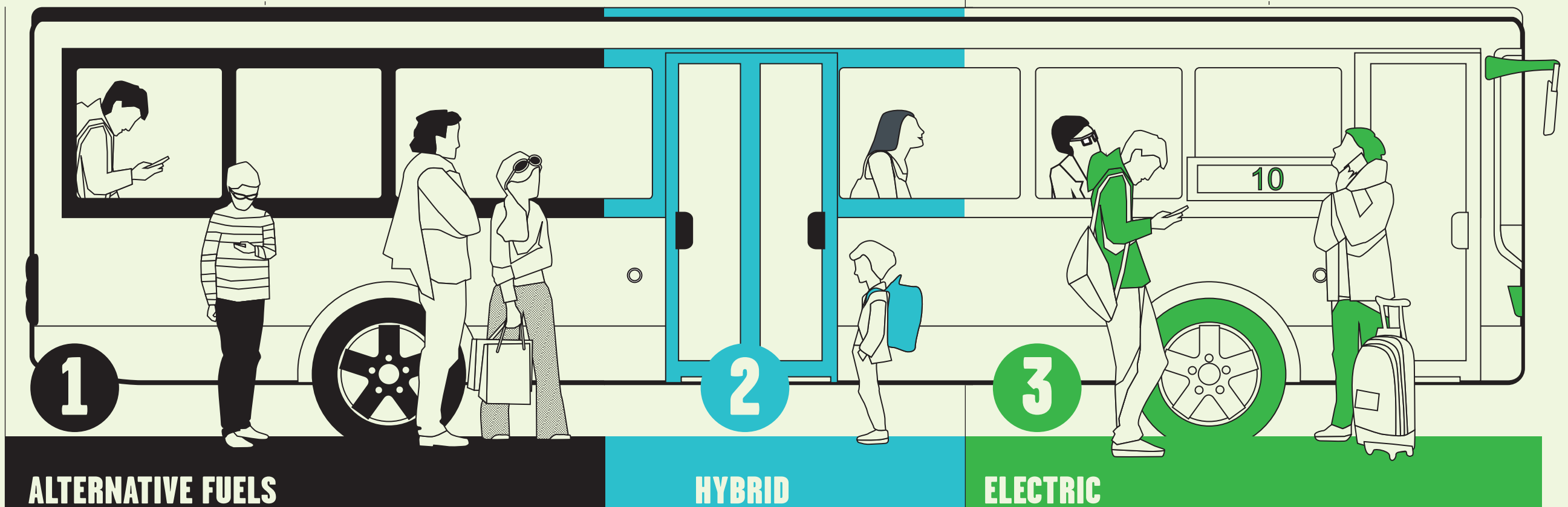
SHENZHEN, CHINA

New energies, the term used by China to express its conversion to electric vehicles, is fully self-explanatory in Shenzhen. On December 27th 2017, the town declared having made the conversion for the totality of its 16,359 buses to entirely electrical ones, way ahead of New York with its fleet of 5,710 electric buses.



PAU, FRANCE

The vote has passed. The town of Pau has decided to power its buses with hydrogen from September 2019. The plan is to equip an entire line. With a fuel cell filled with hydrogen, the buses which can be recharged in 10 minutes, will have an autonomy of 300 kilometres.



ALTERNATIVE FUELS

HVO

(HYDROTREATED VEGETABLE OILS)

Fuel produced from vegetable oils or animal fats.



- No usage restrictions, no specific infrastructure required
- Identical vehicles to diesel vehicles
- Diesel substitute
- Odourless
- Reduces CO₂ emissions



- Limited distribution
- Not available in petrol stations
- Mostly produced from palm oil

NATURAL GAS FUEL AND BIO-NGV



- Technology developed for urban areas, in development for long-distance
- Competitive price
- Very quiet: less than 3dB(A) compared to diesel
- Can be integrated with mild hybrids
- In the medium term, long-distance coaches will be able to run on liquefied natural gas (LNG)



- Cost of recharging infrastructure
- Technology proposed by only one coach manufacturer today
- Maintenance of roof-top reservoirs

HYBRID

2 ENERGY SOURCES

are used together to run a vehicle, one of the two is electric.



- No usage restrictions or specific infrastructure required
- Reduction in fuel use from 20 to 25%
- Extension possible to Zero Emission Vehicles (ZEV)
- Noise reduction in ZEV mode



- Purchase cost of vehicle (+30% compared to diesel vehicles)
- Depreciation of high cost of vehicle spread over many years
- Maintenance of roof-top batteries and electric converters

ELECTRIC

BATTERY



- Zero local emissions (particulates and NOx)
- Low CO₂ emissions (varying according to electrical source)
- Quiet



- Limited autonomy
- Battery charging time
- Battery life cycle
- Battery recyclability
- Purchase cost of vehicle (2x greater compared to diesel vehicles)
- Cost of recharging infrastructure
- Maintenance of roof-top batteries

HYDROGEN

Hydrogen fuel cells together with batteries, can power an electric engine.



- Carbon-free emissions
- Can be produced locally from renewable energies (solar or wind)
- Filling time (approximately 10 minutes)



- Maintenance of cells, roof-top batteries and reservoirs
- Vehicle cost (3x greater than diesel vehicles), recharging infrastructure and fuel
- Technology and network still in development

MEETING

CRAZY IDEAS, GENIUS IDEAS

An engineer, born in Quebec in 1974, Charles Bombardier is the grandson of the inventor of the snowmobile. His love of innovation and motorised engines were the driving force behind the creation of Imaginative in 2013, a platform that promotes innovation and industrial creation.



by Pascal Béria



You can find more innovations on www.imaginative.org

Charles Bombardier is one of those inventors whose only frontiers are those of the imagination. His ideas are sometimes fantastical but always inspiring.

Where did the idea for Imaginative come from?

Imaginative is first and foremost an ideas factory. An invention presented on our site can lead to

improve what's already out there and help society to move forward. If concepts are successful, they can attract big companies who are able to invest the necessary resources into progressing technology and developing new markets.

Does that mean that all the projects you present are feasible?

I trained as an engineer. It's a solid base on which to imagine the future together with broad perspectives. My projects have to be based on rational foundations so

with great freedom which is extremely precious, at the same time though, it's easy to get lost without precise directions.



So where does your ability to shift your mindset come from?

It's a kind of a freestyle based on observation and a particular way of thinking about life. I identify problems and imagine solutions to solve them whilst weighing up the pros and cons that these innovations would bring. I try to open doors so that professionals, companies and the general public discover new opportunities, challenges, issues and shortcomings. By sharing my ideas with the

community, I use feedback to develop them further.

Does imagining tomorrow's mobility mean we have to break with today's framework?

We have to stop thinking of vehicles as a means of getting from A to B. They need to allow us to do more for example, reduce stress, communicate and work better. Also reduce the risk of accidents and why not improve the environment instead of making it worse?

there are many advantages to be gained by drawing inspiration from the two approaches, but I'm also inspired by a third category, that is the industrial designers who are not involved in the actual invention but more its form and functionalities.

And who are the individuals that have inspired you?

Sam Lapointe. He was the first industrial designer at Bombardier Recreative Products



So what is the mad streak that differentiates the engineer from the inventor?

The engineer is trained to problem-solve, one problem after the other, stone after stone. It's a rational approach that is different to the inventor, who will first define his idea and then seek the means to achieve it without necessarily taking the time to check all hypotheses. I find

(BRP). He designed hundreds of snowmobiles, motocross, watercraft and other avant-garde concepts for the company from the 60's to the 80's. When I was a child, I saw and tested several of his inventions. His work and that of other industrial designers, engineers and technicians working at Bombardier Recreative Products have always inspired me (and still inspire me).



the generation of other ideas. Some of them may be one-off projects, others may be spectacular developments. It's fantastic to be active on both extremes of the spectrum.

that the next level can be extrapolated and take our thinking out of the box. I am not linked to any one company and I finance my own projects. This allows me to act

Does Imaginative want to appeal to people capable of developing your ideas?

It's a bit like that. We have an approach that aims to seek out and bring together business groups, scientists and industrial designers so we can



1 Randvu

is a tram-train that runs on both railway and metro tracks, thus avoiding congestion in urban areas.

2 Phantor

are urban autonomous vehicles that watch over our streets. By filming everything that happens on the highways, they act as witnesses to incidents or crimes.

3 Panama and Fünambul

move around in 3 dimensions. They can cross large towns by using overhead network cables and travel vertically by using existing lift shafts.

4 Orizon

is an aircraft project that uses the same modes of propulsion as air travel and can move around in space. It will be possible to leave an airport and spend a week in orbit, in an inflatable hotel.

MELBOURNE'S MOVING ARTWORKS

Created in the late seventies, the Melbourne Art Tram wraps public tramways with artworks. The result of a creative partnership between different players in the city. The idea is to give people the opportunity to be touched by original Melbourne artworks. Returning after a 20-year interlude, the project's blending of public transport and great local artists has proven hugely popular.

by Robert Jack

WRAPPED TRAMS

"The Melbourne Art Trams project could only happen in Melbourne, with our world-class artists and our world-class tram network," says Jonathan Holloway, Melbourne Festival's artistic director.

Now in its fifth year, the annual project invites artists and community groups from the Australian state of Victoria to submit designs that will adorn trams on Melbourne's iconic network, the world's largest. It's a revival of the 'Transporting Art' scheme, which ran from 1978 until 1993. The workmen at the Preston Workshops where Melbourne's trams were painted watched with interest as renowned artists transformed trams into mobile artworks, and over the following four years, a total of 16 trams were painted. The Melbourne Art Trams project involves eight trams each year. The trams are no longer painted, instead the artwork is transferred onto 'vinyl' and 'wrapped' around them.

The project takes contemporary art to a mass audience. More than 1.8 million people board a Melbourne Art Tram each year, and many more experience the designs as they travel on the city's 250 km network. The public can vote for their favourite design and the winner of the People's Choice Award receives an A\$5,000 prize.

A CREATIVE PARTNERSHIP

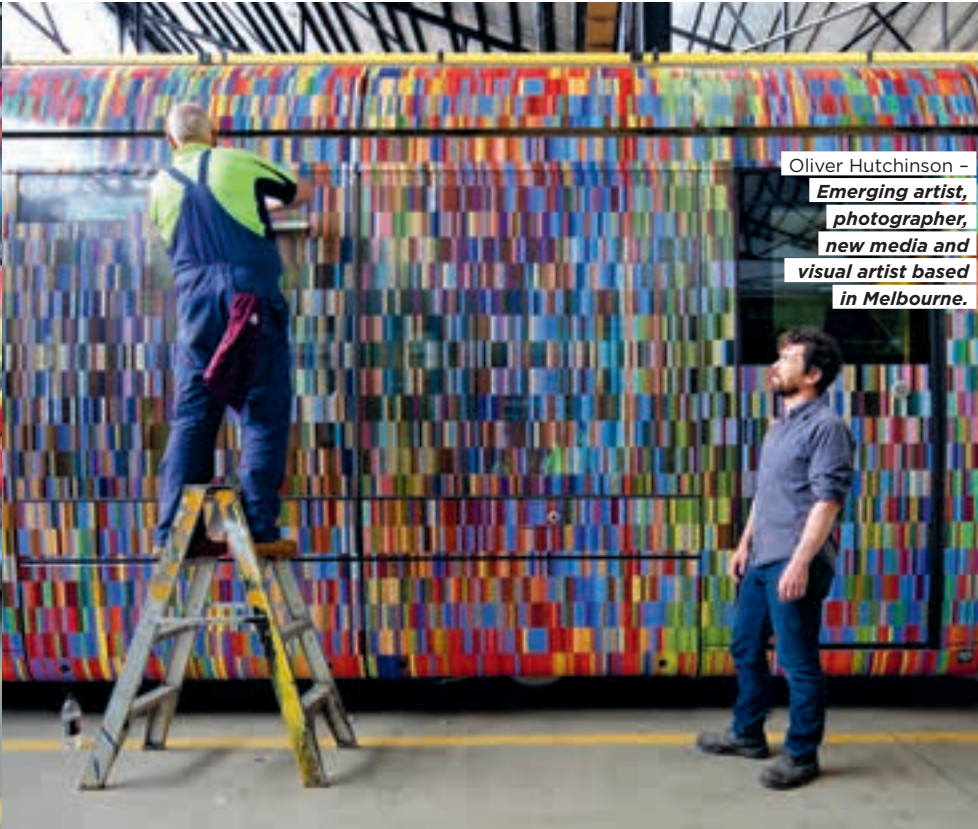
The Melbourne Art Trams project is made possible through a creative partnership between Melbourne Festival, Creative Victoria and Public Transport Victoria in collaboration with Yarra Trams, which operates Melbourne's entire tram network. And Keolis Downer Victoria, the operator of Yarra Trams, facilitates the project each year.

The partners start each February with a public expression of interest for Victoria-based artists. Their selection panel ensures that the artists are representative of Melbourne's diverse communities, and include at least one emerging artist and one community entrant. The eight successful applicants are chosen in June, and the artists then work with Yarra Trams to adapt their designs to the intricacies of the tram's class they have been given to work with (some parts of the trams cannot be covered because of safety or passenger requirements). The trams are then wrapped and are launched in October, coinciding with the annual Melbourne Festival, one of Australia's leading arts festivals.

In addition to having their work paraded through Melbourne's streets for six months on a twenty-tonne canvas, the artists each receive A\$5,000 – and they can double their money if they win the People's Choice Award.



Matthew Clarke – **Artist from South West Victoria, inspired by the environment and people around him.**



Oliver Hutchinson – **Emerging artist, photographer, new media and visual artist based in Melbourne.**



Robert Owen – **A renowned Australian artist who studied sculpture at the National Art School, Sydney.**



Emma Anna – **Visual artist and creative producer whose work draws upon a diverse range of professional and personal experience.**



Josh Muir – **Indigenous artist who is a two-time winner of the National Indigenous and Torres Strait Islander Awards.**



Bushra Hasan – **Artist and graphic designer whose art is inspired by popular Indian street and tribal art.**

“AMAZED BY THE REACTION OF PEOPLE”

The public has fallen in love with the Melbourne Art Trams, and it has become one of the city's major annual public art projects. It has also put the city on the map internationally, with many tourists taking photos that they share with friends and family around the world.

“There's huge anticipation and build up each year when we unveil the designs for the eight trams,” says Philip Askew, General Manager Marketing and Digital at Public Transport Victoria, the authority responsible for providing, coordinating and promoting public transport in Victoria. Passengers can track the real time location of each of the trams using the city's TramTracker app.

“I'm still amazed by the reaction of people on the street when they see these colourful wrapped trams passing through the city or their neighbourhood.”

“It creates a real connection with our passengers and adds to their sense of pride and shared ownership of Melbourne's tram network.”

“It's great kudos for the tram network to be the carrier of this art each year, cementing our place as the iconic image of Melbourne and our role in the community”, adds Emilie van de Graaff, Director, Passenger & Network Innovation at Keolis Downer. “And the trams look fantastic. We love watching this come to life each year and hope it will continue for a long time yet.”



Read the full interview of Jonathan Holloway, Melbourne Festival's Artistic Director on **pulse-mag.com**

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