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The Future of Energy

THE FUTURE OF ENERGY : LEADING THE CHANGE
A SCIENTIFIC PROGRAM IN SUPPORT OF A SUCCESSFUL ENERGY TRANSITION - 2016-2017

HUBS AND NEW / INTER MOBILITIES

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Executive Summary

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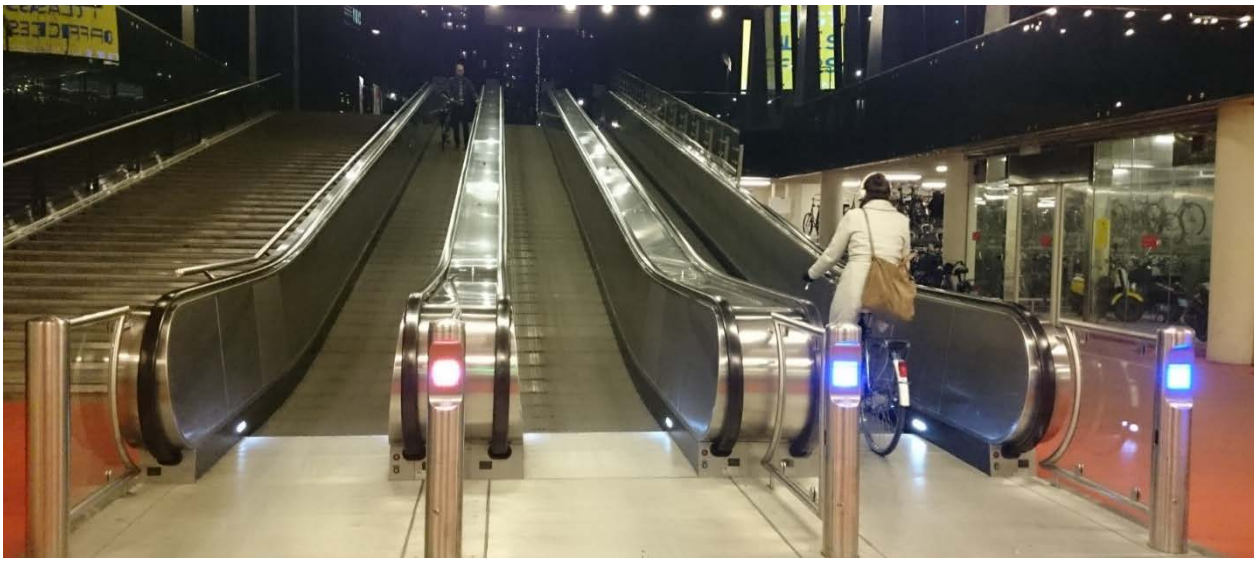


Rotterdam Central Station – moving walkway for bicycles (Photo © LIAT)

This research addresses the current major upheaval in mobility practices and its effects on urban organization and projects, especially hubs and exchange poles.

At the core of our work is a reflection on the modalities of transfer: the goal of transforming the feeder-transfer experience into a continuous journey requires the conception of spaces capable of integrating all new mobilities.

The hub heralds the global evolutions of sustainable movement cities. In the society of exchange, the intermodality of modes of communication emerges as a decisive challenge in the conception of urban architectural projects.

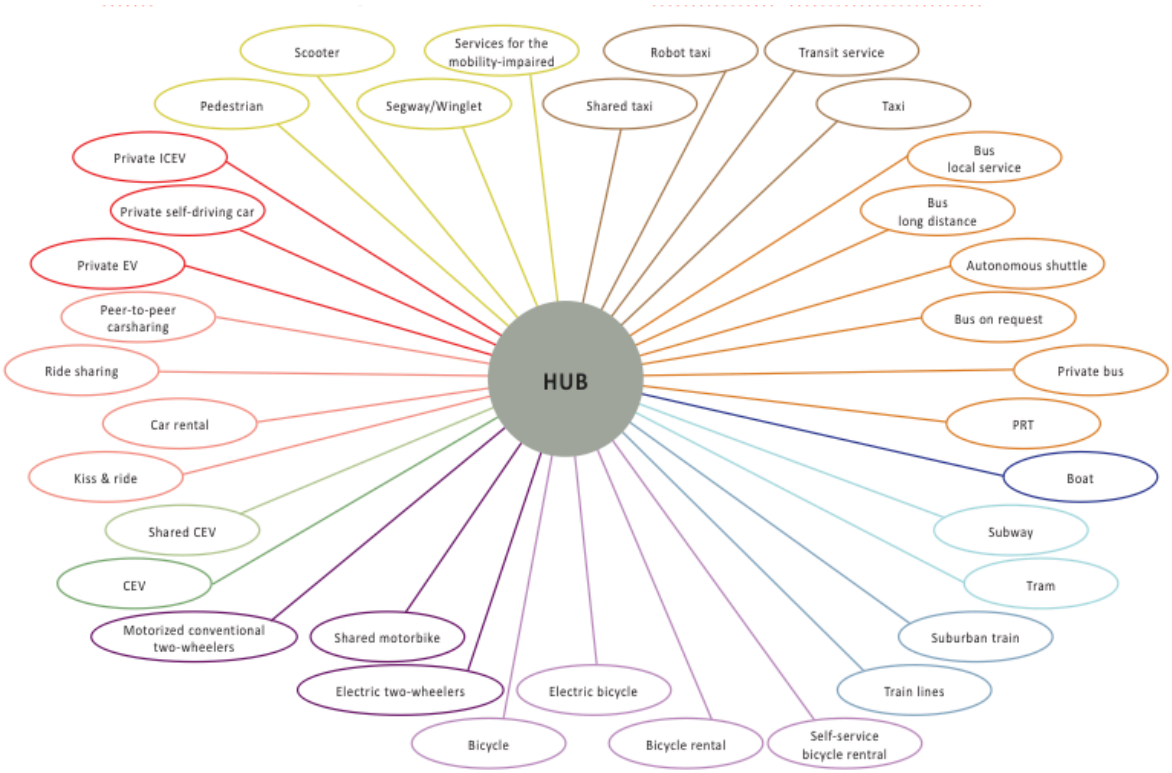
All mobilities

No transport system can single handedly become a complete substitute for the existing configuration(s). Consequently, links, articulations, intermodality and interoperability need to be considered in the context of the multiplicity and entirety of an individual's movements.

Transport offers catering to these needs will become more and more available as a result of the joint demands of sustainable development and the digital economy. They range from "soft" mobilities, which call upon muscular power, such as walking and cycling, to those designed to assist the augmented human of the Machine Age: moving walkways, escalators, electrically-assisted bicycles and all the devices of individual urban ultra-mobility (one-, two-, three- or four-wheel Environmentally-friendly and Connected

Vehicles[1]), public transport and shared personal transport, hybrid, electric and self-driving vehicles, and, of course, internal-combustion-engine vehicles (at least for a while)…

In the near future, over thirty different modes of transport and their different practices might coexist at hubs. These facilities bear a relationship with a variety of spaces: lanes for pedestrian and vehicle movement, transfer spaces, waiting and parking areas, electric vehicle charging facilities, areas for provision of services and retail activities. Together, they bring a new spatial complexity to all interchanges and hubs, simultaneously overflowing them. Such "spaces of access", already identified in our *Door-to-door* research, can be of any scale: from parking areas for carsharing services and electric vehicle charging stations which will gradually accommodate other transport modes and services, to the intermodal metropolitan hub.



More than 30 different modes of transport expected to coexist in hubs (© LIAT)

This research delivers:

1/ **an appraisal of European-funded actions** carried out from the 1990s to this day, with a goal to develop expertise, knowledge and experience regarding interconnection and intermodality within hubs;

2/ **a cartographic analysis of railway stations and other intermodal hubs** which are currently in the process of being built (Greater Paris Express network) or have recently been completed in fifteen European cities ~~and Japan~~, with a focus of the existence and quality of the new mobilities offer;

3/ **thinking points and proposals** to be considered in the transformation of intermodal spaces and in the choice of typologies to be applied to the future hubs of new inter-mobilities. Here, our case studies of Japanese cities were our main source.

[1] Dominique Rouillard, Alain Guiheux, *Door to door. Futur du véhicule, futur urbain*, Paris, Archibook, 2015. (English version: *Door-to-door. Future of the Vehicle, Future of the City*).

With the first two goals in mind, we carried out a state of the art regarding projects that either already completed, currently underway or projected for the near future. The intention of the survey was to establish a benchmark of the current knowledge in the field of intermodality spaces and also, reaching further, of the "initiatives" undertaken by city administrations, companies and universities faced with the challenge of developing new, environmentally-friendly mobilities. While the issue of intermodality and its spatial concerns has not always been on the agenda (in fact, rarely so), awareness of the "environmental urgency" is nevertheless real, and abundant are the means available to address it through transport and mobility solutions. We chose to collect and preserve this rich information, even though it was often provided by default, in a context where concrete solutions to the subject of intermodality are still lacking...

As part of our research, around 70 reference institutions and individuals were contacted and interviewed on the site of their activity, in the various cities where our case study hubs were located. We thus met with representatives of public and private transport companies, university research units focused on the future of mobility, applied research centres of the transport sector or others concerned with virtuous development in the field of transport, as well as with organizations and groups which are actively developing and promoting environmentally-friendly mobilities.

Our research did not undertake user surveys (contributing to the bottom-up perspective). We considered that existing scholarly work had already devoted considerable efforts, in terms methodology and resources for inquiry, with a goal to undermine customers' perception of mobility services and possibilities for intermodal practice (*infra*, European-funded research).

1. EUROPEAN RESEARCH PROJECTS, FUNDING AND EXPERIMENTATION SINCE THE LATE '90s.

The issue of intermodality, and more accurately that of interconnexion, emerged in the 1970s in the context of research looking for alternatives to the use of internal combustion engine vehicles. From the late 1990s onwards, European-funded research programmes have focused on this subject. No less than twenty research programmes have since then been financed on this topic alternatively referred to as interchange, exchange, interconnexion, seamless transfer, cross-modal mobility, multimodality, intermodality…

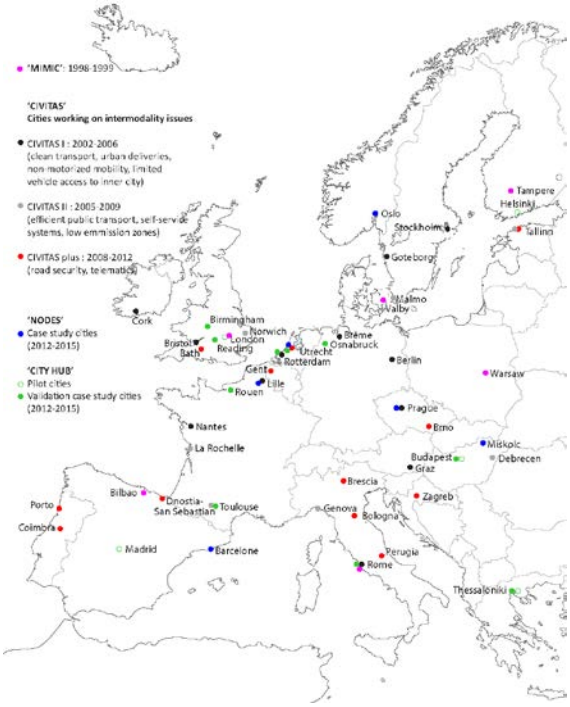
The assessment of such studies has, in turn, become the object of further research. Some of these undertakings have competed with each other (notably NODES and CITY HUB projects, both launched in 2012 and completed in 2015[2]) and proceeded through methods and hypotheses similar to those already in place. Most of these studies can be said to have focused on users' perception and their (compulsory) experience of intermodality. The main goal of this kind of research has been "to build a framework of a structured evaluation of the necessary and desirable to improve interchanges and intermodality" (MIMIC, 1999[3]).

One could, however, wonder whether the majority of the issues flagged as problems – later referred to as obstacles or "barriers" to intermodality in the MIMIC project – had not been already identified from the very first research efforts financed by the European Union (HSR-Comet 1996-1997[4]): the overall too long walking distances between connections, the lack of comfortable waiting areas, the difficulty or even impossibility for disabled people to gain access to train carriages, the insufficiently secure and weather-

[2] CITY-HUB: Innovative Design and Operation of New or Upgraded Efficient Urban Transport Interchanges (09.2012 – 02.2015) ; NODES: New Tools for Design and Operation of Urban Transport Interchanges (oct. 2012- sept. 2015).
[3] MIMIC: *Mobility, Intermodality and Interchanges* (01-1998 – 06.1999).
4 HSR-COMET: *Intermodal Connection of High-Speed Railway Terminals in Metropolitan Areas*.

protected bicycle parking facilities, the absence of shops and other retail services available to commuters during waiting or transfer time, etc.

Fifteen years later, the two main conclusions are that “benefits of interchanges mainly relate to time saving and better use of time”, and that “people may accept to walk longer to an interchange based on its aesthetic and the comfort it offers” (CITY HUB report).



45 European cities engaged in 4 European-funded research programmes on intermodality: MIMIC, CIVITAS, NODES, CITY-HUB (1998-2015). © LIAT.

The H2020 European program shows that attitudes have evolved. On the one hand, the topic of “Smart mobility in cities”[5] has been introduced; on the other – and regardless of the marginality of the project –, a new approach has been added to the usage perspective, which raises questions about the travel mode itself and as to whether innovation could not come (also) from the vehicle used for transfer from one mode to another (« Bike Intermodal »[6]). A shift in attitudes that echoes our line of thinking about “inversed mobility” (*infra*).

Our investigation of European-funded research actions and case study hubs (recently completed and currently underway) demonstrates that the multiplicity of new mobility practices as well as the new modes of transport and the spaces devoted to them have not been sufficiently taken into account. We argue that the way research activities have been framed, to this day, has largely contributed to this oversight.

- **Methodology has not been sufficiently updated to fit contemporary contexts, problem issues and social configurations**:
  - Inquiries have mainly taken the form of user surveys;
  - Users concerned by new and still marginal practices have insufficiently been taken into account;

5 Smart, Green and Integrated Transport - FP8 EU Program: H2020: 2 programs: 2014-2015 + 2016-2017.
6 Bike Intermodal: H2020, 2015.

- Analysis has been based on existing conditions of travel in existing stations;
- Research teams dealing with the same topic have not communicated thoroughly enough nor put themselves in competitive environments to achieve complementary results.

- **Aims and deliverables have not always been consistent**:
  - The goal to measure and to evaluate has been the driver of research;
  - The overriding concern to find a common European-wide standard has led to a reduction of complexity and local particularities;
  - There has been delay in seriously taking into account the last mile issue;
  - Prospective research and ground-breaking solutions are still lacking;
- Insufficient attention has been paid to architectural and urban design, and to the role of spatial organization.
  Work has too often been aimed at an audience of researchers:
  - Research has been mostly carried out by transport scholars and engineers;
  - The development of software-based solutions for seamless travel has failed to consider the spatial dimension and the complexity of interoperability;
  - The focus has concentrated on the interchange function within railway and underground systems;
  - Research has lacked a multidisciplinary approach (sociologists were often the sole representatives of human science disciplines, as they were called to the rescue by engineers).

None of the European-funded projects has been fully devoted to depicting the relationship between spatial layouts and the performance (and perception) of the interchange.

2. HUBS IN PROGRESS

- The **Greater Paris Express** (GPE) network, 200 km of new metro lines (supervised by engineers) and 65 stations (handled by architects).

By using chrono-geographic maps, our research once again accurately demonstrates[7] that only few of the new stations to be created, expanded or connected as part of the GPE project will offer increased accessibility to the users, and that the existing of feeder transport will inevitably be maintained. We argue that users will continue choosing the car in situations where the walking distance exceeds 5 minutes, and even more so in environments lacking the attractiveness of commercial activities and other services.

The bicycle – a key card in the SNCF and the STIF's last-mile mobility policy (the 'Veligo' concept) – will not be the answer to all situations. This non-motorized two-wheeler, operating at a speed of roughly 2km per 10min, will not offer an efficient solution to those who travel longer distances and/or require faster, more comfortable or otherwise more adequate options. We are convinced that new modes of transport, that could deliver shorter travel time and respond to individual mobility needs, are yet to be developed and implemented, as are the spaces of their use and their interconnexion with other means of travel.

[7] A demonstration had already been made in the framework of an initial cartographic study, published in our research unit's report *Door to door. Future of the Vehicle, Future of the City*, in the chapter « Proximity, an idea that is growing distant ».

The conception process of new interchanges for the Greater Paris Express was divided in two phases: the first one concerned the "station box" (the station building and the underground space), and the second one the outside forecourt (the public space adjacent to the station building and its immediate surroundings). From the outset, intermodality was not adequately taken into account in the design of station projects for the GPE network. In fact, no intermodality requirements were put forth to the architect teams who submitted their candidacies during the first call for proposals regarding the "station box" (2015). To remediate for this omission, in February 2016, the Greater Paris Society created the "Public spaces and intermodality unit" with the mission to solve the issue of intermodality.

Chrono-geographic maps of the Greater Paris. © LIAT. A comparison between accessibility to GPE stations in 2016 (on the left), and in 2030 when 31 new stations will have been created (on the right). Both maps show 5-minute travel time distances, covered at 4 different speeds:

- **Recently completed stations and ongoing experiments – a comparative analysis of the current state of intermodality in European cities.**

Two categories of interchanges were selected; our goal was to analyse their intermodal performance (refer to the graphic analysis report).

1/ Stations where the issue of interchange has been backed by the MIMIC project (1998-1999):

London: Stratford (station redevelopment project to prepare for the Olympic Games of 2012);
Rome: Ponte Mammolo (redevelopment of an existing bus interchange, built in 1996);
Tampere: Tampere Intermodal Passenger Terminal (redeveloped in 2014-16);
Copenhagen: Valby (recently redeveloped interchange, 2010-2012);
Bilbao: BILBAO, Central station + Bilbao Termibús, Abando (built in 1996, redeveloped in 2006);
Warsaw: Wilanowska/Pulawska (existing hub, to be redeveloped in the near future).

2/ Stations which were part of the NODES and CITY HUB case studies, and/or which were selected due to their involvement in the CIVITAS initiative (as part of work packages dealing with intermodality).

12 case study sites were selected in the following cities: Hertogenbosch, Rotterdam, Utrecht, The Hague, Amsterdam, Bremen, Berlin (Sudkreuz railway station, as well as the EUREF campus hosting the

headquarters of INNOZ), Gothenburg, La Rochelle. Grenoble was the sole exception: while the city's central station has not been part of European projects, the Municipality is currently the sole European partner of the Toyota car manufacturing company for the development of their intermodal mobility concept 'Ha:mo'.

The twelve case study interchanges were mapped and analysed in view of highlighting two aspects: 1/ the traditional, conventional mobility offers, and 2/ the new mobility offers. A series of diagrams show the proximity of access to such services, with a reference walking distance of 300m (corresponding to a time distance of approximately 5 minutes).

Amsterdam Central railway station 1999-2004-2017

Amsterdam is said to have the densest electric vehicle charging infrastructure in the world: in 2014, the city passed the milestone of 1000 public charging stations (mainly for plug-in hybrid electric vehicles), and the aim is to have 4000 charging stations by 2018. There is also a growing interest in electric bicycle ownership (with purchase numbers doubling since 2014). However, new mobilities remain scattered around the central station area, further from the traveller than conventional mobility services. Our research found that there is a rich infrastructure of bicycle parking facilities: there are around 25 000 racks in public spaces near the central station, among which 13 000 are public and privately-owned low-fare supervised storage units and 4000 are free-of-charge municipal supervised storage units. In addition, several hundred parking spaces are provided on boats, which are docked along the Amstel river bank on the back side of the central station. All in all, bicycle parking facilities are rarely sheltered and remain located outside the station building.

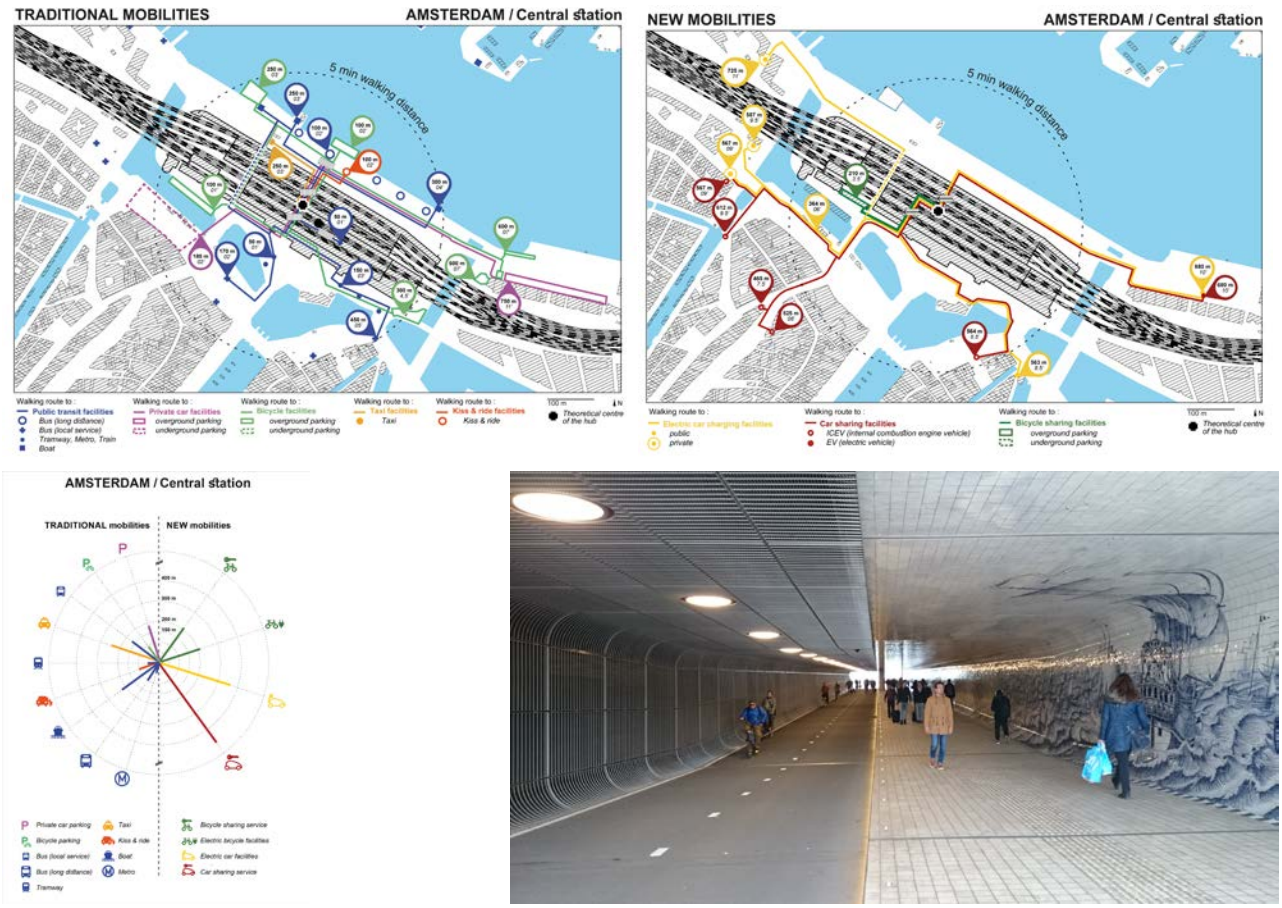


Diagram of time distances for reaching traditional and new mobilities - A tunnel for cyclists and pedestrian (© LIAT)

Rotterdam interchange redevelopment project (2003-2014)

Besides the "grand gesture" of its vast canopy and a spacious station hall – part of the visibility agenda for the new high-speed railway service –, and the enhancement of connections via the metro system, the most stunning feature of the Rotterdam central station is the moving walkway for bicycles – an impressive piece of infrastructure leading directly to the station square.

Utrecht Central station (2008-2015)

In the university city of Utrecht, the number of cyclists is higher than anywhere else in The Netherlands. An underground three-floor bicycle parking facility for 12 500 bicycles (known as "the largest in the world") is supposed to be the solution. According to the architects' team, the transfer time for bicycle users could not exceed 5,5 min. Within this short time distance, users are expected to ride all the way up to their parking space (and not walk, which is usually the case in this kind of facilities), or, inversely, to reach the train platform by using three spacious staircases and multiple underground tunnels connecting the bicycle parking facility to the numerous train platforms.

Berlin Südkreuz railway station (2011-2015)

The reconstruction of the Berlin Südkreuz railway station was an opportunity to develop an integrated system of transport modes and means of individual mobility (national innovation programme 'Schaufenster Elektromobilität'). The main goal was to design a model hub for the future comprising: a micro smart grid with renewable energy sources (wind turbines and photovoltaic panels); a station for carsharing services (ICEV and EV); conventional and electric bicycle sharing services; a local electric bus fleet, recharged by means of an inductive plate embedded in the road surface; a charging station for private and shared electric vehicles. All new mobility services are displayed in front of the station, thus increasing their visibility from the traveller's point of view.

Grenoble station - Toyota's vision of sustainable mobility (2014-2016)

The Japanese car manufacturing company chose the city of Grenoble to develop its intermodal system 'Ha:Mo' (Harmonious Mobility): an electric ultra-compact car sharing concept for dense urban areas. The renovation of the old railway station of Grenoble made it possible to shorten the distance between different modes of mobility, successively located along the main façade of the passenger building. Today, the facilities provided comprise:

- The 'Métrovélo' service for bicycle rental, repair and maintenance, and two multi-level bicycle parking facilities built on each side of the station (with a capacity of about 700 parking spaces);
- A bus terminal with a traveller waiting area;
- A carsharing service giving access to 'i-road' and 'Coms' compact vehicles for short-term lease, provided under the 'Cité Lib by Ha:Mo' label.

3. NEW HUBS FOR NEW AND INTER-MOBILITIES

Our research approach and methodology are founded on the tracking of outstanding examples as well as of weak signs that, we believe, may stimulate the possible evolutions of hubs in the immediate future. Japanese stations, recognised as the world's most performant, have thus weighed significantly in the conception of our proposals.

- **A vast common space**

We have called our first hypothesis "the vast common space".

The lack of noise and air pollution associated with the latest, environmentally-friendly electric vehicles favours their growing presence at multimodal hubs and make it possible to follow principles developed in the sheltered, multi-storey modern interchanges of the 1960s .

The station is thus **a machine-like building, sheltered and protected, that accommodates all programmes and intermodalities under the same roof.** The silent and clean nature of environmentally-friendly vehicles favours this integration of modes, services and spaces at the architectural scale. While buses and taxis were the first to be present in such buildings, personal vehicles have remained side-lined, either parked underground or stored in outdoor parking lots, less and less tolerated at drop off points. Nevertheless, as we have already shown in the *Door-to-door* research, the separation of mobility modes is no longer relevant, especially with the profusion of cycles and environmentally-friendly and communicating vehicles. Dutch and Japanese examples show that it is possible to cycle inside hubs, and that these soft mobilities have found their legitimate place inside the facility. This evolution allows to minimise the travel time distance inherent to intermodal mobility.

We have considered as equivalent all programs present within the station.

Whereas in preceding decades stations were conceived as a set of separate programs, it has now become relevant to consider integrating all programs within a vast common space. To put it differently, intermodal programs will be combined and intertwined, or integrated as part of a larger walking sequence, together with other programs, commercial activities and various related services. We wish to reiterate, here, that the more the service and retail activities are gathered near railway platforms and hub exit areas, the more they are ergonomic for users. Commerce and mobility services have historically developed overlapping relationships by means of spatial links at the ground level, underground or within the higher levels of the hub. In Japanese stations, this is a central pattern, with aerial, underground or ground-level shopping malls having been built at connection areas. In the *Door-to-door* research, we also demonstrated the importance of providing virtual shops on railway and metro platforms.

The vast common space will also be flexible, inspiring itself from airport terminals, which have since become shopping malls.

The majority of stations will therefore become **multi-functional programs** which integrate spaces that are made available for various future activities, in particular spaces where travellers can simply relax, meet, work or do homework at their leisure.

Within the vast common space, **the pedestrian-user is the measure of all movements**; **his/her speed of movement and comfort experience will dictate all other activities**.

The internal atmosphere of the vast common space ensures the functioning of the station, which is organised, above all, **from the ergonomic perspective of movement** and **by an "architecture of time" that makes comfort it's first priority.**

Gathering all modes as close as possible to the railway, **organising a "sustainable" succession of modes along the chain is part of an overall time management strategy.**

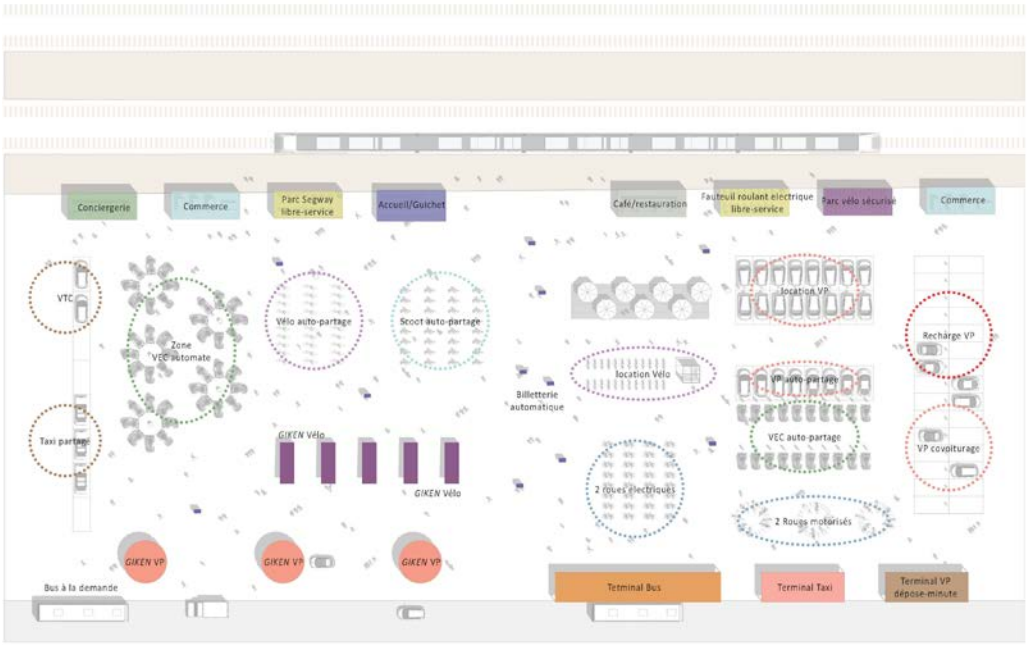
What would still lack in the vast common space would be a shared, spacious area for all activities to take place.

Finally, let's point out that the vast common space is also **a place for genetic transformations**. The experience of boarding or descending from trains and buses no longer means a transition from cold to warm environments or the other way around. The space of the interchange has become a sheltering continuum, expression of a new level of comfort brought to the intermodality experience.

- **A revolution: the vehicle comes to you**

Our second hypothesis consists of inversing how we understand and interpret vectors of movement. While we still consider that it is us who must move towards these vectors, a more efficient configuration would be that we expect them to move towards us. This relevant mindset change dictates a separation within the parking function, or in the management of the pick-up and drop-off areas. Comfort and space economy are thus enhanced. The arrival of autonomous vehicles will even further accelerate this transformation: “Hello, VEC, come and get me, I will be waiting at point X…”

Below is a synthetic representation of hub encompassing most of our hypotheses within a single continuous space.



The vast common space for all mobilities (© LIAT)