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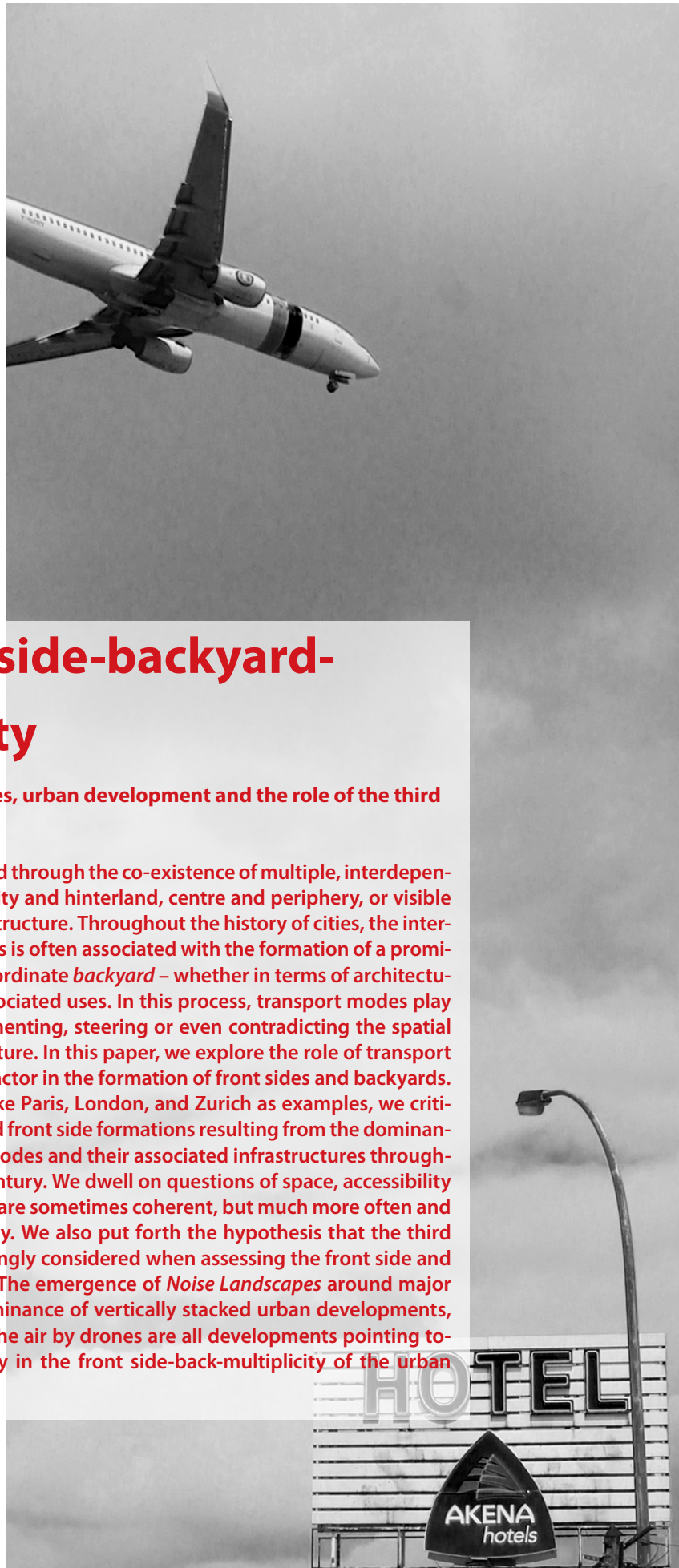
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The front side-backyard- multiplicity

Transport infrastructures, urban development and the role of the third dimension

Urban space is constituted through the co-existence of multiple, interdependent polarities, such as city and hinterland, centre and periphery, or visible façade and hidden infrastructure. Throughout the history of cities, the interweaving of such polarities is often associated with the formation of a prominent *front side* and a subordinate *backyard* – whether in terms of architectural form, function, or associated uses. In this process, transport modes play a complex role, complementing, steering or even contradicting the spatial layout of the urban structure. In this paper, we explore the role of transport infrastructures as a key factor in the formation of front sides and backyards. Taking European cities like Paris, London, and Zurich as examples, we critically review backyard and front side formations resulting from the dominance of specific transport modes and their associated infrastructures throughout the 19th and 20th century. We dwell on questions of space, accessibility and impact, aspects that are sometimes coherent, but much more often and increasingly contradictory. We also put forth the hypothesis that the third dimension has to be strongly considered when assessing the front side and backyard phenomenon: The emergence of *Noise Landscapes* around major hub airports, the predominance of vertically stacked urban developments, and the colonization of the air by drones are all developments pointing towards further complexity in the front side-back-multiplicity of the urban structure.

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Transportation, and the phenomenon of front sides and backyards

Transport and urbanization are strongly connected, having developed mutually in consecutive surges. Geography and transport, and later mobilities studies, refer to waves of transport development: each wave is associated with a new technology that fundamentally affected the mobility of people and goods, and consequently urbanization.¹ In the early stages of the industrial revolution, walking and horsecar-riding were the main inner-city mobility modes, while canals and waterways spread development inland. The invention of the steam engine in the 19th century led to the expansion of railways, intensifying inter-city transport and turning train stations into epicentres of urban life. By the mid-20th century, the diffusion of the internal combustion engine had popularized the automobile and led to the widespread construction of highways and road networks, encouraging suburbanization. Finally, the introduction of commercial jet aircraft in the second half of the 20th century made airports the anchors of global mobility, introducing new influence factors to urban development. These major developments have been complemented by other transport modes such as bicycles, trams and buses, or most recently electric scooters, with varying impacts on different urban contexts.

Transport waves have produced a complex mesh of mobilities laid across our urban, suburban, and rural settlement structures.² Importantly, new modes did not replace the previous ones, but supplemented them.³ In consequence, urban form is conditioned by the pre-existence and co-existence of several modes of transport and the economic rationales and cultural frameworks of the respective epoch.

Common among transport infrastructures are the conflicting effects that they have on their surroundings. Specifically, the interplay and superimposition of transport modes in urban space produce instances of its *polarization into front sides and backyards*. *Front sides* stand here for the "prominent" side of modern city

development, associated with higher value, centrality, and often iconicity. *Backyards*, conversely, stand for its subordinate, reverse, sometimes even anarchic side.

It has been argued that in the post-Fordist era of constantly expanding and varied mobility, polarization is a decisive factor in urban development and can take on extreme forms. For instance, Graham and Marvin have discussed the rise of "splintered geographies", in which transport systems provide distinctly different services and spatial accesses to premium users, as opposed to poorer users and bypassed areas.⁴ Thomas Sieverts, whose concept of the "Zwischenstadt" is a powerful tool for interpreting contemporary urbanized landscapes, has analysed large-scale transport infrastructures as both connecting and disrupting: they trigger the formation of enclaves as much as they facilitate centrality and define urban form.⁵ And in his influential work "Ladders", Albert Pope has shown that the lattice-like development of urban form is inherent to a modernistic idea of the city revolving around the automobile.⁶

Another aspect to consider is the alternation of extensive and intensive transport modes. While intensive modes are based on a small number of interconnected hubs, extensive ones rely on a multitude of points that are hierarchically more equal.⁷ It can be observed that the waves of transport development follow an alternate pattern of these two configurations.

With the latest transport revolution, the airplane, this development has taken a turn into the vertical dimension, adding more complexity to the front side and backyard polarity. In our previous work on airport areas, we have observed growing contrasts between, on the one hand, highly connected nodes and their access channels and, on the other hand, their "impact territories", which support the node's functionality by absorbing externalities like discontinuity and nuisance. The "backyard" condition of such territories is primarily induced by the noise carpet of flying airplanes.⁸ This occurrence is one of many that point to an "urbanization of the air", with tangible



Backyard of a typical Parisian block. 3. Eirini Kasioumi (2017).

impacts on urban space – yet another considerable shift in how transport infrastructures influence urbanization.

This short reflection points to the fact that the front side-backyard duality has three major dimensions: space, accessibility, and impact. *Spatially*, the duality is expressed by typological properties such as the position and dimension of buildings, the width of urban spaces, and the position of public and private functions and entrances. *Accessibility* is strongly determined by the type of transport: Extensive transport modes usually create accessibility along a line, while intensive modes increase the accessibility of points. The *impact* of transport lines is reflected on their various emissions on the one hand, and on the various flows that they prompt on the other hand.

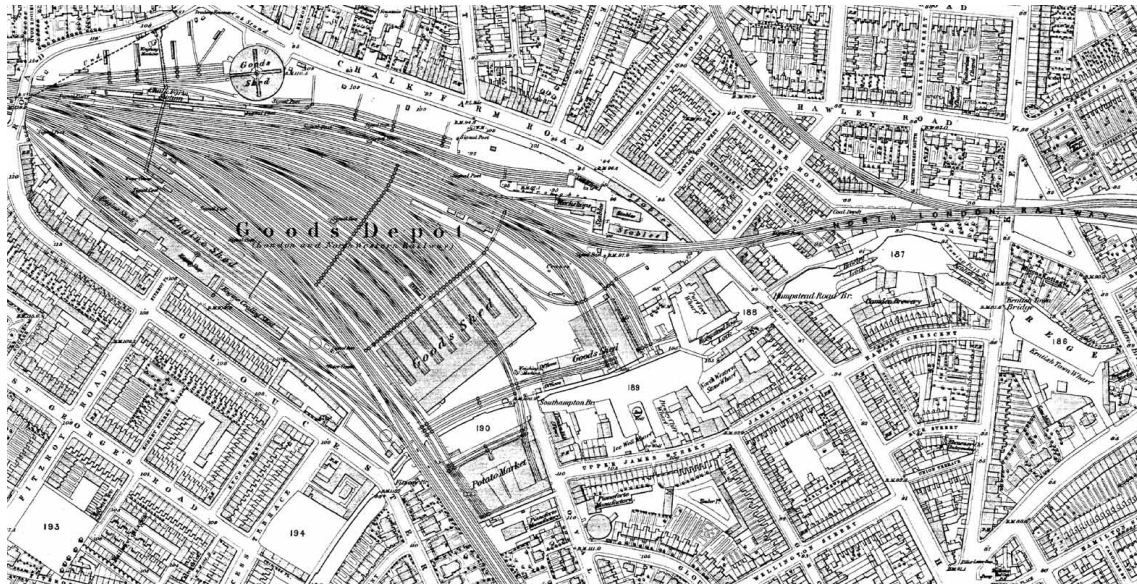
In considering this complex phenomenon on the basis of these three dimensions, this paper has two major aims. First, we aim to elaborate on the front side-backyard duality as one inherently connected to modernity. Existing references to this duality focus on how modernist ideals disregard the cultural and aesthetic value of transport and other infrastructures, viewing them as utilitarian systems to be relegated to the "backyard".⁹ Less has been said on the infrastructures' own ability to polarize urban space. Thus, we conceptually and empirically enrich existing approaches by reviewing examples of the production of front sides

and backyards in major European cities during the 19th, 20th and 21st centuries. In so doing, we also attempt to verify to what extent the contemporary condition produces greater spatial polarization – demonstrating that, rather than a simple duality, urban space increasingly consists of a multiplicity of several overlaying dualities.

Second, we reflect on the potential future evolution of the front side-backyard phenomenon, especially in view of the "urbanization of the air" – an increasingly plausible scenario thanks to the rise of drones and other gravity-defying mobility modes. This scenario would signal the advent of a new wave of "extensive" modes, along with their "verticalization", bringing multiplicity into the third dimension.

Boulevards: Urban devices of polarization

The accessibility by foot and horse-drawn carriage defined the structure of settlements for centuries. The spatial layout of European medieval cities was mainly a result of the superposition of paths, houses and light infrastructures. These types of transport did not have a strong polarization effect on the urban structure. Taken together with the limitations of construction methods and the lack of city planning authority, it meant that users occupied space rather homogeneously. An obvious differentiation occurred vertically at the scale of the in-



Map of the North London Railway chunk between the West India Docks to Camden Town, built in 1850. Jack Whitehead, "The Growth of Camden Town: AD 1800 - 2000" (1999).

onal vertical economic organization was complemented by a form of *vertical social stratification*: the wealthiest people would occupy the second floor, the middle class the intermediate floors, and the lower-income tenants – often concierges and servants of the wealthier residents – the top floor, under the roof. The higher the floor, the smaller the apartments, the lower the ceilings, and the less elaborate the architectural detailing.¹¹

In parallel, the new representative front sides produced by the new boulevard landscape meant that lower-value functions – such as less expensive dwellings and urban manufacturers and industries – were pushed deeper down in the respective plot, into the existing urban tissue.

Even though the Haussmannian project was unique in its comprehensiveness and intensity, similar transformations of the urban structure occurred in many other European cities of the 19th century. Examples of new major boulevards catalysing spatial polarization as in the Parisian model can be found in Vienna (Ringstrasse) and Berlin (Friedrichstrasse), among others.¹² In London, where private initiative prevailed over state-led capitalism, the front side-backyard duality was best epitomized by the grand estates, with the mews as the backyard condition.¹³

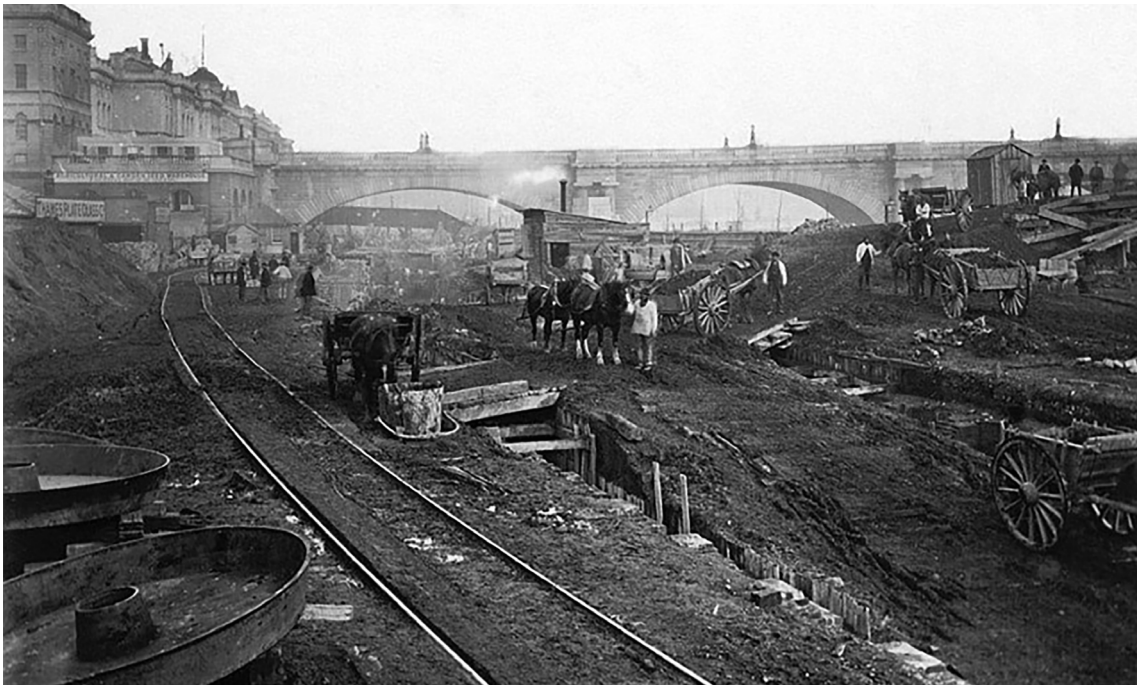
Thus, the development of modern European cities seems inescapably con-

nected to the creation of front sides and backyards – developed as a tool of sanitation, of control, of social distancing, and as a means of capitalistic development. The boulevards also show that extensive transport infrastructures have the potential to flip frontside – backyard relations inside the urban tissue relatively quickly and radically.

Railway stations: Connectivity-induced backyards

As the era of the boulevard was underway, the era of the railway was on the rise, too. In fact, Haussmann's network of boulevards aimed to connect the city's train stations. His project even included the construction of two new stations, Gare de l'Est and Gare du Nord. Napoleon himself considered railways as the roads of the future, and the new stations the real gates of the city.¹⁴

These new gates, proliferating in Paris, London, and many other European cities in the second part of the 19th century and the first years of the 20th, unleashed an unforeseen dynamic between transport node and city. Though their placement was largely chaotic, based on existing infrastructure and availability of space, their impact was enormous. Railway lines first demonstrated how strongly transport infrastructure can exercise both *pull* and *push* forces. In terms of their *pull* effect, the stations quickly drew urban development and became



On top: Construction site to the west of Waterloo Bridge, 1866-1870. Museum of London (ca.1866-1870).

Above: Zurich Hauptbahnhof, today. Werner Huber, "Bahnhofstrasse Zürich" (2015)..

centralities. In Zurich, for example, the construction of its main station was accompanied by that of the Bahnhofstrasse as a main commercial street, together shifting the city's new centre of gravity away from the traditional, medieval city.

Yet the approach lines leading to the new stations cut through the urban structure violently, leading to the demolition of thousands of homes and to the degrading of the areas they crossed¹⁵ – a *push* effect. This was perhaps most dramatic in the case of London, where railways became agents of slum clearance: it is estimated that

more than 76.000 people were driven out of their homes due to railway expansion between 1853 and 1901.¹⁶ The approach lines towards the urban train stations, occupying an enormous amount of land and interrupting communication between formerly connected parts of the city, can be considered as the backyards of railway development: shoddy areas plagued by emissions – witnesses of the time, for example, describe the disturbance of clockmaker workshops due to railway-produced vibrations. Not surprisingly, it was mostly industries that settled near the railway lines: pushed away from upscale areas, fac-

tories and manufacturers found here ample space and good connectivity, as rail segments would be diverted to serve them. They thus accentuated the backyard condition of these areas.¹⁷

and business centres were often developed. Thus, railway stations both intensified existing polarizations of the urban structure, and created new ones.

Below: A section of the Boulevard périphérique from the 18th arrondissement. Wikimedia Commons "Boulevard périphérique, 18th arrondissement" (2010).

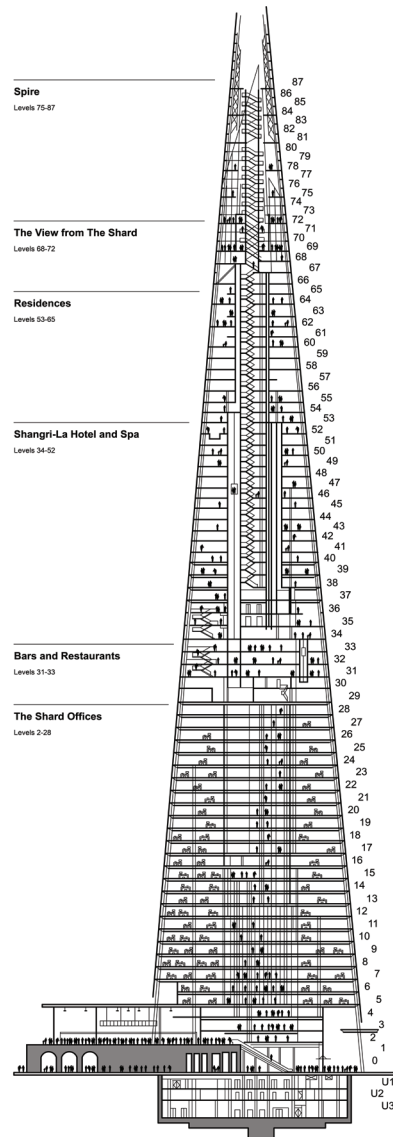
Bottom: Aerial view from 1961 showing the construction of the Boulevard Périphérique between Vanves and Châtillon. Mémoire 2Cite, Flickr.

The development of railways testifies to the ability of intensive transport modes to create *impact territories*; and hence, to reconfigure urban areas functionally, socially and economically. As factories settled around railway tracks, they reinforced the segregation of their low-income workforce that usually dwelled in their vicinity. Conversely, at the front sides of the railway node major commercial

Highways: The emergence of inner and outer peripheries

While the cities of the railway bore resemblance to existing urban structures, the next wave of transportation, the car, prompted a new kind of settlement – urban sprawl. The formation and problematic of urban sprawl have been extensively described in the literature.¹⁸ By catering





Section of the Shard showing the layout of the functions at different levels.
 Wikimedia Commons "The Layout of the Shard" (2013).

to the extensive transport mode that is the automobile, highways made a much larger area accessible than before, leading to the emergence of automobile suburbs in outer peripheries.¹⁹ Thomas Sieverts described these areas in his *Zwischenstadt*, turning the attention of planners towards a phenomenon that had been largely overlooked until then.²⁰

While railways had also supported the creation of metropolitan sub-centres, highways did so less predictably, prompting less easily classifiable urban forms – from the suburban subdivision to the commercial mall to the car-oriented business park. Accordingly, the front side-backyard relationship became more complex. Motorway junctions, for instance, are amongst the most central points of a metropolitan region, but at the same

time repel urban development. Consequently, while the connecting properties of the car had been in the foreground at the beginning of its rise as a dominant transport mode, its dividing character became more and more apparent, with highway projects often encountering strong resistance from affected communities.

In particular, highways feeding city centres caused *inner peripheries*: areas that, although geographically in a central location, are locally poorly accessible and thus perceived as remote. The noise and other pollution caused by the car turned the surroundings of inner-city arteries, built all around Europe during the 1960s and 1970s, into underprivileged enclaves. The *Boulevard Peripherique*, built around Paris in 1973, is a prominent example: in the collective imaginary, it marks the end of the compact, well-organized city and the start of the discontinued and unpolished suburbia.²¹

Concerning the effect of extensive transport modes, the effects of highways confirm the observation made earlier with the boulevards regarding their potential to override previous conditions. In addition, highways testify to the ability of new transport infrastructures to prompt new and unexpected settlement structures that redefine whole regions – such as the dissolution of the traditional city cores through suburbanization and sprawl.

Elevators: The verticalization of the city

Even though the elevator is not directly comparable to railways or highways, it has been almost equally transformative, as it opened up the world of vertical transportation, which in turn enabled the building of cities upwards. According to Stephen Graham, *elevator urbanism* has not received the attention it deserves in social scientific discussions of urban space, which have largely focused on horizontal mobilities and transport infrastructures.²² Yet the technological progress in elevator engineering has triggered a significant skyward shift in the architecture of recent decades, further encouraged by the sustaina-

bility-prompted imperative of higher density.

This vertical mode of transport restructures the question of front sides and backyards in yet another way. Vertical urbanization seems to be creating its own spatial polarization. The social stratification seen in Haussmann's apartment buildings becomes inverted: it is now the wealthiest residents or premium users that occupy the uppermost floors, especially in the highest buildings. At the same time, several levels underground often provide the infrastructure of the building: machinery, parking, etc. Thus, the elevator signals a "verticalization" trend in the building stock that, through its proliferation, becomes formative for the urban structure as a whole.

Subways: Democratic connectors?

At first sight, the existence of subways seems to run against the hypothesis of a front side-backyard duality. But in fact, subways are important for this hypothesis, precisely because they are the exception, and they may also hold an important lesson for the future urbanization of the air, that we deal with in the final part of this paper. As they are constructed underground, subways are the most expensive way to connect different parts of a city. But they have no negative externalities on

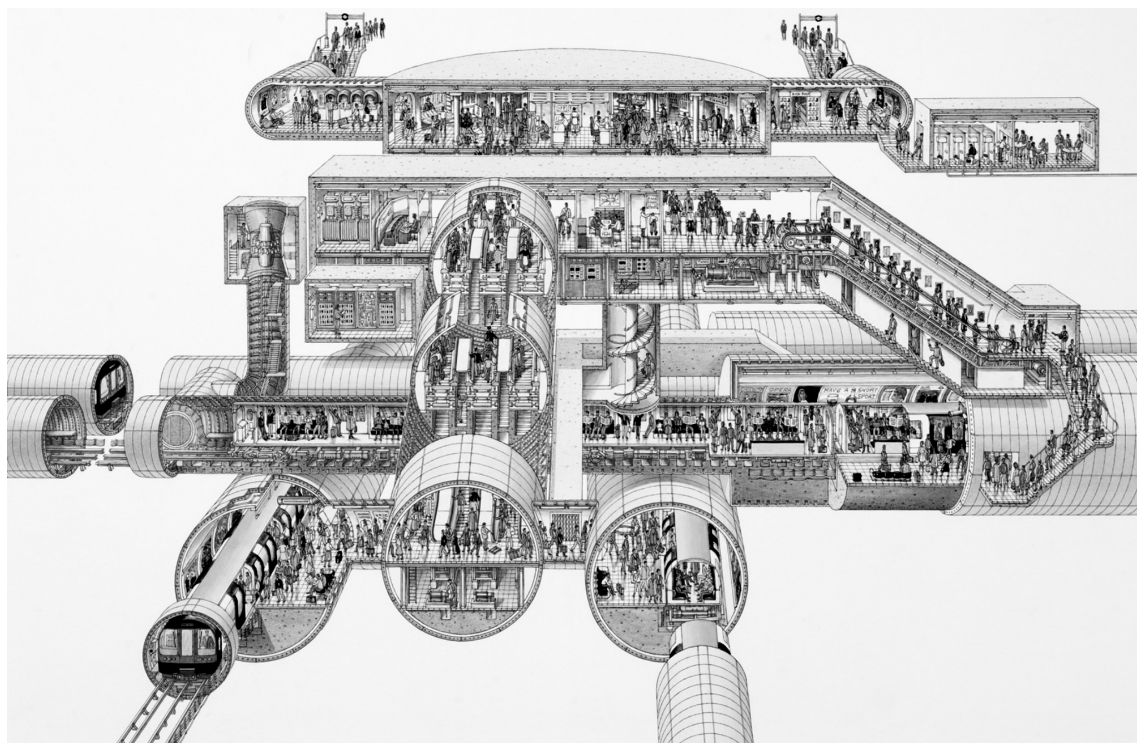
the overground urban structure. This stems from the very nature of the mode: although the subway network is *horizontal*, it is *layered vertically* under the city. This prevents the subway from impacting its built surroundings through emissions, while it very much influences their accessibility.

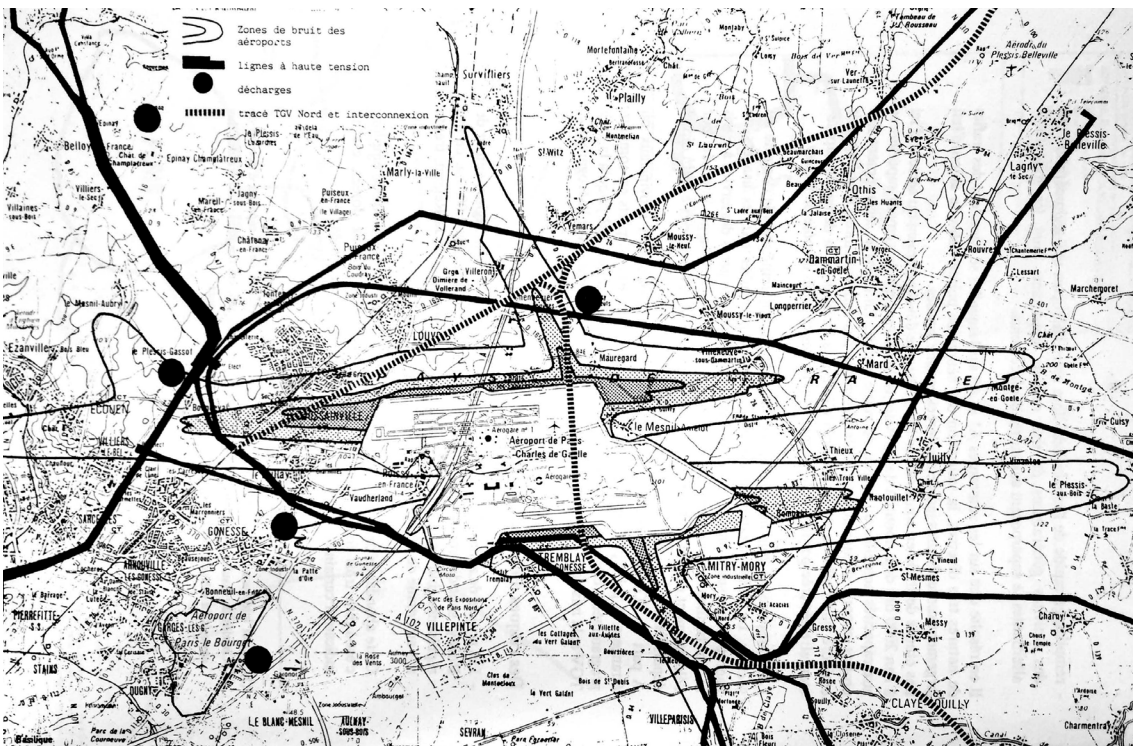
Subway stations may produce front sides by attracting central functions and greater urban density, especially in the case of new metro systems. They influence the value of the nearby plots, and likewise trigger gentrification, but they hardly produce any backyards. Further, in a dense subway network, one line can link very different neighbourhoods, for example, high-income with low-income areas, and increase mutual accessibility. Without negative externalities, traffic infrastructures thus appear to become democratic connectors: They leave the spatial structure unaffected, while greatly enhancing its accessibility.

Airports and Noise Landscapes: Backyards of unintended consequence

The jet age has brought changes to city form and structure that are still poorly understood. Like subway systems, air travel networks are *layered vertically over* urban space. Air movement channels are outside the urban realm, whi-

Conceptual section of a metro station showing the interconnectedness of the layers underground.
Stephen Biesty "Subway Station" (2019).





On top: Warehouses in Massy, west of Paris Orly Airport. Eirini Kaisoumi (2017).

Above: Plan of the noise zones of the Paris Charles de Gaulle airport and other disturbing infrastructure (railway, high-tension lines, landfills), as depicted by the Paris planning authorities in 1989. Institut de l'Aménagement et d'Urbanisme de la Région Ile-de-France, Mission Exploratoire "Développement du Pôle de Roissy" (1989)

there is an extreme concentration of flows at the airport node. But unlike subways, this singular point captures a vast zone around it, whose main role becomes to support the node's function: from the technical facilities supporting terminal operation to the areas under the approach and departure paths of airplanes and the ground access and provision infrastructure.

Inside the airport itself, spatial polarization is shaped by the boundary between *airside* and *landside* with

varying degrees of access and exclusivity.²³ More important for our analysis are the areas around the airport: chiefly distinguished by the aircraft noise pollution that they incur, these areas constitute the complex spatial phenomenon of the *Noise Landscape* that we have introduced in previous work.²⁴ In extensive studies of airport areas in Paris, Amsterdam and Zurich, we identified Noise Landscapes as backyards that often stand in dramatic contrast with the airport node. In addition to aircraft-induced noise and



Low-value businesses in the area of Chilly-Mazarin", west of Paris Orly Airport. Eirini Kaisoumi (2017).

air pollution, with considerable effects on the environment, human health and land values,²⁵ other traffic-induced conditions shape their character as well, as airports are usually served by both highway and railway access lines.

These backyards feature a compartmentalized urban structure, heterogeneous visual appearance and ad-hoc mix of land uses, and are often home to chronically disadvantaged social groups.²⁶ In a similar way to railway backyards, they attract industry

and logistics; but there are also parts where high-value businesses thrive. Inside a backyard situation, a front side can swiftly appear – for example, if a direct connection to the airport is introduced. The Zurich airport area exemplifies such different situations: The airport's immediate vicinity constitutes a prestigious front side, epitomized by the upscale office, retail and convention centre "The Circle". But a few hundred meters away, there are low-income housing areas in the municipality of Opfikon, positioned

in an "inner periphery" situation between highways and railway lines.

Airport areas demonstrate that the latest wave of transport development produces complex effects on the urban structure. By combining horizontality and verticality and by acting cumulatively in relation to existing transport infrastructure, air transport has transformed the front side-backyard condition so, that there is no simple way to understand and represent it any more.

Drones and logistics: The new urbanization of the air

We have arrived in the 21st century, and at the question whether airborne mobility will make another significant step in the next decades. If distributed widely across the urban tissue, Urban Air Mobility (UAM) most likely will come with their particular form(s) of urbanization; and with their own concerns of safety, privacy and noise.

The widespread availability of personal drones has already introduced an invisible geography above the ground where no-fly zones and regulations define a volumetric zoning through geo-fencing. As drones multiply, specific routes will have to be defined for them, especially in lower altitudes corresponding to the urban environment, with pertinent control, coordination and regulation mechanisms. UAM also depends on distributed physical components, in forms of stations or hubs as permanent additions to the settlement structure, in urban and rural contexts alike. Along with the urban scale, front side-backyard configurations at the architectural scale could also be challenged, as "former understandings of thresholds, barriers, overlookings, windows and enclosure become anachronistic in the path of such airborne agents".²⁷ In essence, not just vertical, but three- and four-dimensional approaches to understanding this form of urbanization will be important in the coming decades.

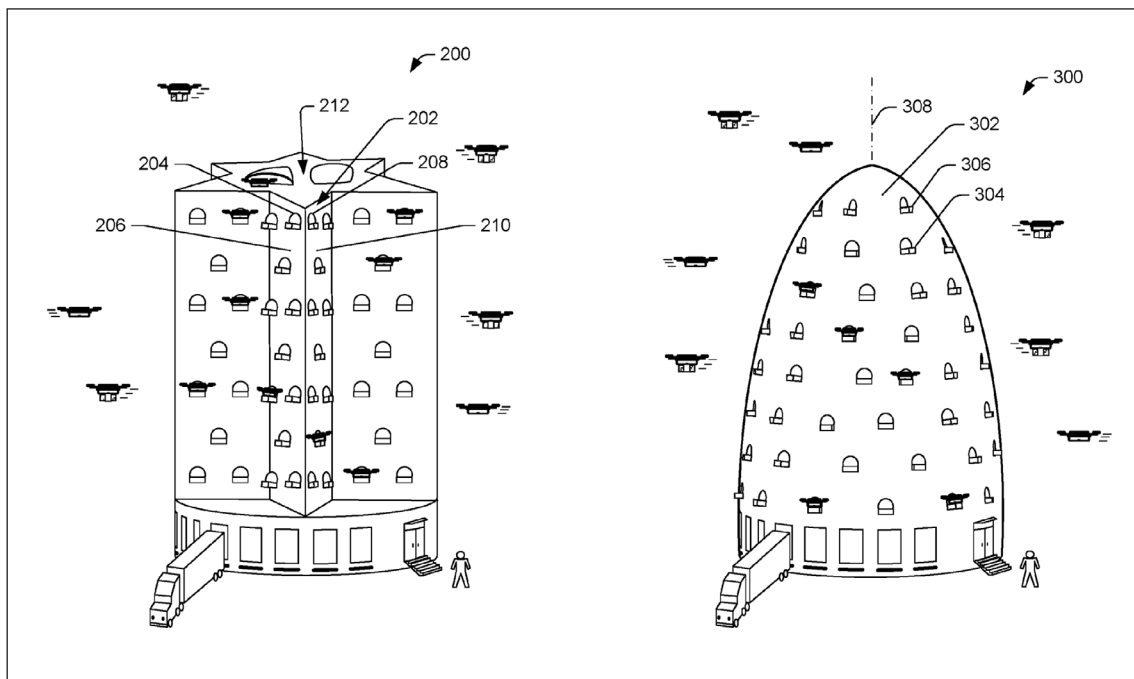
UAM is far from its final form. However, the variations in size and form of UAV (Unmanned Aerial Vehicles) and their adoptability offer what other airborne mobilities, like helicopters,

lacked. From the distribution of goods and services to aerial taxis, from surveillance to emergency services, from agriculture to roof inspections, UAM instances are rising in number and variety every day.

Recently, the Corona-Crisis led drones to be utilized in aerial disinfection, transport of samples and deliveries but also as crowd control and quarantine enforcement agents in China.²⁸ In Switzerland, "vertiports are already being used on a daily basis" since 2017 with "service drones carrying medical supplies between laboratories and hospitals" reaching 500 drone flights/month. Private companies like Amazon and DHL are testing cargo drones' capabilities for distribution of goods and services, while Uber is working on a prototype for air taxis for "world's first urban aviation rideshare network" and also on designs for "skyports".²⁹ This anticipation has already led to the first *front side real estate*: in London, the startup Skyports has bought the rights to 15 rooftops for UAM uses as they expect it to be a "regular occurrence" as soon as 2021.³⁰

With digitalization acting as a de-facto facilitator, UAM can be claimed to already bid its time. However, UAM's widespread adoption still depends on many factors, as it requires the acceptance of governance, commercial, and also civil actors. Technological constraints and environment, safety, privacy and noise-related concerns will play an important role, especially in urban contexts.

Airspace, much like the underground, is unbound by ground conditions, and likewise almost democratic in nature: apart from the restrictions defined by rules and regulations, infrastructural and technical capabilities, all air space is essentially equal. Therefore, the backside/front side dichotomy could be challenged by UAM both in vertical and horizontal dimensions: Ground floor/top floor relations may be reconfigured as the rooftops become prominent, façades may gain new functions and become more permeable, courtyards may become access-points and thus novel front sides. Moreover, the street space and existing inner-city transport infrastructure may



Patent Drawings of the UAV Ports by Amazon. Curlander et al., "Multi-Level Fulfillment Center for Unmanned Aerial Vehicles" United States Patent US 9,777,502 B2 (2017).

be reconfigured in light of the vertical extension potentials. As they generate new backyards and front sides, UAM forms hence have the potential to flatten and re-define polarization, perhaps more extensively in urban environments than other airborne agents. Like every other technology, they have the equally large potential for a negative impact as well – in the case of UAM this could especially concern increased surveillance possibilities and the disturbance of privacy of private space in general.

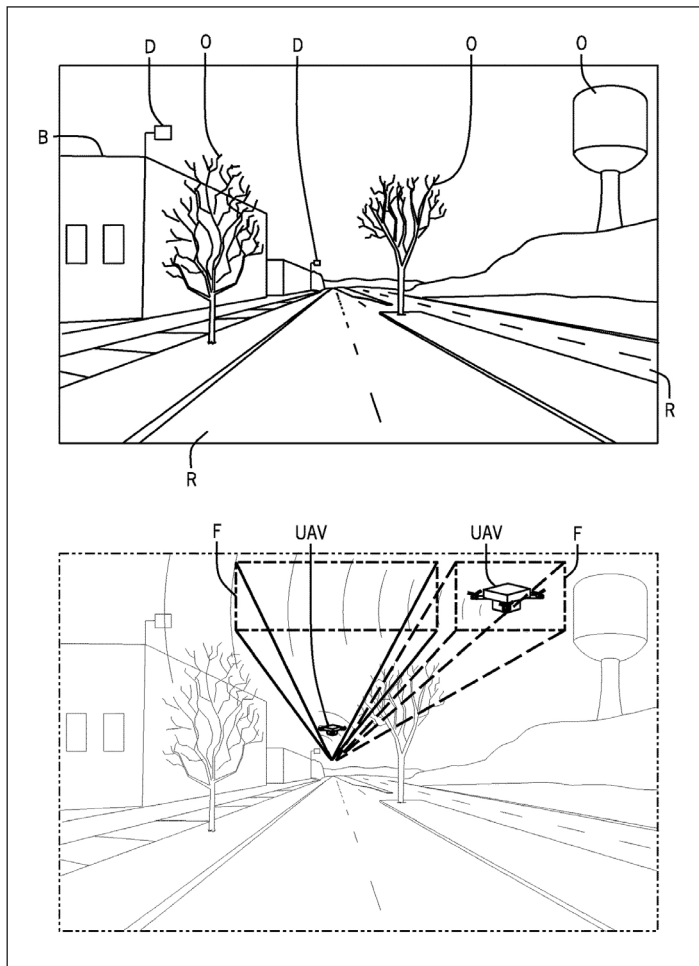
Conclusion: What will become of the "flattened space of polarization"?

The connection between traffic infrastructures and the development of front sides and backyards can be seen as a dominant thread throughout the 19th and 20th century. During this time, cities have transformed from simple front side-backyard-dualities into complex, multi-layered configurations. As space has become increasingly connected, two trends become discernible. First, as the speed of transport and its territorial extent reach novel levels, cumulative transport development appears to come to a peak.³¹ This can be understood as a symptom of the global trend conceptualized as the Great Acceleration: the era of unprecedented growth of human activities experienced in the last century.³² Second, the ubiquity of connectivity in the urban structure has

resulted in increased polarization and, one could say, in the "backyardization" of large parts of the urban structure.

Space, as a result, has become both more flattened and more polarized, and as we look back on the last two centuries, we realize that these two properties cannot be separated. It appears that the Great Acceleration has brought us a *flattened space of polarization* covering our cities like a chaotic, unevenly woven carpet.

How could this space evolve in the future? We are writing this article during 2020, as the Corona-crisis unfolds across the globe. Although its long-term social and economic effects are still unclear, we understand this crisis as a first sign that the epoch of the Great Acceleration is ending – an expectable development. This must also challenge our reflection on the impact of transport infrastructures, calling into question the very idea of a "next wave" of transport development, and that of the predictability or even necessity of transforming our cities' physical structure in the next decades – a mindset for which we yet have to establish the intellectual framework. We are currently experiencing a sudden slowing down of the Great Acceleration. While it is to be assumed that our societies will try to resume acceleration as quickly as possible once the virus is under control, this crisis may well foreshadow a 21st century in



Above: Patent drawings for distribution of the UAV network utilizing the lower air field of the current infrastructures. Chan et al., "System and Method for Management of Airspace for Unmanned Aircraft", United States Patent No: US10,134,291B2 (2018).

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which periods of acceleration will alternate with periods of deceleration or even crashes, resulting in partial collapse of some systems.³³

Airborne mobility will thus probably not take the linear development path that the preceding forms of mobility have taken and that had turned them into new dominant modes of transport. Rather, the next transport revolution may be completely different in character and could indeed be already happening: the development of a multitude of light, decentralized transport modes, both on the ground and in the air, linked to digital tools. This is also plausible given the alternate pattern between intensive and extensive transport modes. And, as a corollary to a potentially far-reaching societal and economic paradigm shift, if our societies work towards a positive, progressive and egalitarian scenario, it could be one component of a vast democratization project, leading to a weakening of front sides and backyards – at least if urban planners and others involved in the development of our cities push into this direction together.

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