

REGIONAL LRT AS A BACKBONE FOR THE PERI-
URBAN LANDSCAPE:
Research by design on an intermodal public transport network
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Abstract

Public transport and the periphery have a troubled relation. In search for a more sustainable mobility, the idea of re-shaping the city is more appealing than the idea of re-shaping public transport. Public transport for the ‘car-oriented’ periphery is considered utopian, with a lack of density as the knockdown argument.

The Belgian region of Flanders certainly seems to prove this. An inefficient bus network covers almost the entire territory, but only 15% of its costs. Two types of public transport have remained somewhat successful: the train connections between cities and the bus lines within cities. The periphery, in which mobility is situated on an in-between scale remains dependant on the car. Is public transport for suburbia an impossible task? New concepts such as Light-Rail Transit (LRT) and Bus Rapid Transit (BRT) have emerged over the last decades. They blur the lines between classic PT concepts, and are able to adapt themselves to the structure of the contemporary city.

The region of Klein-Brabant is a typical peri-urban nebula, lacking a legible structure. The difficulty of defining this specific spatial condition, requires planners to propose a new spatial vocabulary for this type of territory. This research-by-design shows how the infrastructure of a regional public transport system (LRT) can become the backbone of Klein-Brabant after the sprawl.

From a theoretical point of view, intermodality has a great potential, as it increases the number of possible connections exponentially. In reality however, organizational issues prevent peripheral public transport networks from functioning as a real ‘network’. The assumption of overcoming these issues allows to discover the spatial potential of intermodality. It stimulates the nodal function of a station in a network, expanding its role as a carrier of (sub)urban programs. In Flemish planning practices, many master plans for small-scale station areas are currently being developed by municipalities, trying to enlarge their capacity as an urban center by transforming their mobility nodes.

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The relevance of a light rail network for Klein-Brabant is to a great extent related to the dispersed urbanity of the region. This kind of network functions through a large number of nodes at a small scale. These nodes ground the concept of mobility, making it tangible on a specific location, and within a network their role is increasingly important. Public transport thus gives way to nodal development, as a sustainable alternative to the ribbon development along secondary roads. The paper elaborates on a specific scenario for LRT implementation, namely heavy to light rail transformation, as part of a bigger research by design. Spatial morphologies are tested and proposed through this scenario.

This design proposal is part of an ongoing research project, called ORDERin'F³ (*Organizing Rhizomic DEvelopment along a Regional pilot network in Flanders*).

1. Introduction: heavy to light rail transformation

On the former Zoetermeer Stad-line and the Hofplein-line, two heavy railtracks between Rotterdam, The Hague and Zoetermeer, the Randstadrail⁴ combines an extension of the Rotterdam Metro network and the tram network of the Hague. Although major infrastructural works redirected the terminus of the Hofplein-line to Rotterdam Central Station, the rest of the trajectory follows the former train connection between these cities. The trains were replaced with faster and more frequent light rail vehicles. The main advantages of this transformation are a densification of stops and a better level of service. Existing stations were remodeled, with urban renewal occurring in their surroundings, while large scale new developments were simultaneously planned and are being executed around new stops. These stops offer extensive possibilities in terms of intermodality, connecting with bus lines and bicycle routes.

Similarly, the Atlanta Beltline⁵ aims at a transformation of an abandoned railway corridor into a tangential tramway around the city of Atlanta, integrating it in a linear park structure called 'The Beltline Emerald Necklace'. Along the Beltline strategic interventions are planned, focusing on affordable housing, economic activities and public infrastructure.

A more modest use of regional rail connections as a catalyst for urban renewal can be found in the Swiss Canton of Zug⁶. Nine new stops were created along the two Stadtbahn-lines, creating a string of new public spaces. However, these stops are more than nodes of modal change; the stations often restore pedestrian and cyclist connections, giving the station a central position in local networks. Additionally, the architecture of the stations is consistent along the entire line, thus strengthening the regional identity of the Stadtbahn network. Although the project in itself is not

³ OSA, BUUR, IMOB, MOSI-T, Lab'Urba, ORDERin' F, Organizing Rhizomic Development along a Regional pilot network in Flanders, Research Proposal (2009).

⁴ For more information on this project: <http://www.randstadrail.nl/>

⁵ For more information on this project: <http://beltline.org/>

⁶ For more information on this project: <http://www.zvb.ch/>

groundbreaking from an architectural point of view, the fact that this was realized in a Canton of only 113.000 inhabitants, with the main city as small as 26.000 inhabitants, is impressive. It shows that low densities can provide the critical mass required for regional railways to succeed.

In the Parisian public transport network as well, suburban tangential connections are made by tram. Both in the case of the T2 and the T4 tramways⁷, former heavy railway infrastructure was transformed into light rail. On the former line between Puteaux and Issy-Plaine, which was in use for heavy rail between 1889 and 1993, operation of the T2 tramway started in 1997. For the T4 tramline as well, a heavy rail line was transformed into light rail, although in this case, a hybrid between tram and train was developed, making it the first Tram-Train in France (2006). The current trajectory runs on train tracks and at heavy rail voltage, while future expansions will be integrated in the regular tram network, taking over its technological characteristics. In 2010, the Tram-train concept was pushed even further in France, as the Tram-Train Mulhouse-Vallée de la Thur⁸ opened. This line, which connects urbanizations in the Thur Valley with the city of Mulhouse, shares the railway track with regional heavy rail trains.

These projects show how the renaissance of the tram not only influences urban mobility, but also aims at establishing fast connections on a regional scale. In the examples mentioned above, this is realized through the transformation of abandoned or active heavy rail lines. Although this approach has only been put in practice systematically during the last decade, the major technological hurdles have been tackled since the 1960's, with the development of a regional public transport network around Karlsruhe (Cervero, 1998). The tram network of Karlsruhe makes use of four different systems, all of which integrate heavy rail infrastructure with light rail vehicles, through the technological adaptation of both.

When dealing with new infrastructures, a general ascertainment is the near impossibility to obtain public support, as their profound interference with the urban tissue automatically causes resistance. For public transport infrastructure this applies even more strongly, because trajectories deliberately seek out urban concentrations, as this provides the system with potential travelers. One possible way to avoid this issue, is by realizing a new system on existing infrastructures, without disturbing the tissue of the urbanized landscape. This possibility has been studied for the Flemish context in 2008, when an evaluation of 104 railway lines on their potential as candidates for light rail transformation, was published (Kauffmann, 2008). Based on this evaluation, three test cases were elaborated. The research focused on the condition of infrastructure and stations, travelers potential based on the existing spatial context, necessary adjustments to track configurations, traffic impact, travel time, exploitation costs and the commensal opportunities of planned developments. Although a wide array of characteristics was considered in the aforementioned study,

⁷ For more information on this project: <http://www.stif.info/>

⁸ For more information on this project: <http://www.solea.info/>

the potential impact such a transformation could have on spatial developments has not yet been explored. This paper intends to bridge this gap by approaching the topic of heavy-to-light rail transformation from a designerly point of view.

The next paragraph argues the relevance of this spatial potential through three arguments: one based on historical ascertainments, one by looking at current planning phenomena in Flanders, and one by learning from foreign reference projects. Subsequently, the topic of this paper and its methodology is framed within the research project from which it originates, after which the actual research is elaborated, first through an analysis of the region that serves as a test case, next by a design-based exploration of the transformed rail infrastructure and its context. Finally, some conclusions will be formulated.

2. Three perspectives on the issue: historical, current and foreign practice

To understand the distinct spatial patterns in the urbanization of Flanders, often referred to as the ‘nebular city’, one must look at the role that railway infrastructure played in the genesis of this landscape. Famous for its dense network of heavy and vicinal railways, the spatial impact of industrialization was quite different in Belgium in comparison to other countries. All across Europe, farmers were attracted by the job opportunities offered by city-bound industries, resulting in urban growth on the one hand and a rural exodus on the other hand. This was first documented in the late nineteenth century by Ravenstein (1885) and articulated into his ‘Laws of Migration’. In Belgium however, the industrialization process had a different imprint on the landscape. As argued by De Block (2011), the dense network of railways allowed for agricultural laborers and farmers to transform into industrial workers without forcing them to leave their ancestral villages. Population growth occurred without considerable migrations, and urbanization was not a process of expanding cities, but of a balanced growth in communities of all sizes. Polasky (2004; 297) has framed this phenomenon within the objectives of Belgian politics. The fear for corruption of the working class when concentrated in the city, was tackled by an increase in mobility between the city and the territory.

Thus the Flemish territory – which today is among the most densely urbanized regions in the world, yet has only four cities larger than 100.000 inhabitants (including Brussels) – is a testimony of the structuring potential of railways. They have been a main instrument in steering nineteenth century urbanization, and has done so well into the twentieth century, until mobility and accessibility became even more ubiquitous thanks to the car and dense road network.

Although public transport in Flanders has reclined into a mostly intra- and interurban system, the spatial patterns still lead to diffuse mobility patterns, nowadays covered by car mobility. There is a little coherence between the spatial structure of Flanders and its public transport system, as regional trains and buses do not offer an adequate level of service to the suburbanized territory, resulting in a modal split that is not very favorable for public transport (Verthetsel, 2007). Furthermore, planning

documents do not predict a remediation in the near future. Against this background of a weak regional public transport system, it is remarkable how many municipalities are planning a redevelopment of their station surroundings (Blondia, 2012).

Since the end of the 1990's, many of the bigger cities in Flanders started struggling with capacity problems of their stations. Because of that, several expansions, renovations and infrastructural changes were planned. Sparked by a new focus within planning policy on the central cities, these projects became levers for the renewal of station quarters, resulting in master plans and development strategies, as is the case in Leuven, Antwerp, Ghent, Liege, ... Urban design was introduced as a planning practice, and spatial planning gained a new dimension of a bottom-up project driven approach. Not only were these large scale station area operations influencing urban planning in Belgium, they also inspired smaller towns to invest in their stations.

The last years, a significant amount of master plans for small-scale stations was developed, and is currently under realization. They are very different from the bigger stations redevelopments, from concept to realization. The limited amount of program and resources and the lack of critical mass and density that encompass these projects, forces design proposals to tackle a maximal number of spatial complexities with a minimal number of interventions. They deal with the specificity of the nebular urban landscape in very different ways, but all of them highlight the role of public space in a peripheral context. With more and more of these projects emerging, spatial strategies are becoming recurrent. The knowledge and insights surfacing from these projects is currently being captured and shared by a number of towns in an Interreg-funded expertise network⁹.

At the same time as these small towns are redeveloping their station quarters, the level of service of public transport is being diminished. In December of 2011, 170 train connections per day were dropped by the national railway company. By 2014, 23 other lines will be cancelled. Nearly all of these are regional connections¹⁰, servicing many of the stations surroundings that are currently being planned. The bus network, which has nodes in all of these stations, is under pressure as well, as a 60 million euro budget cut (6% of the yearly budget) is being carried out in 2012 by the regional public transport authority. There is thus a strong discrepancy between the growing spatial ambitions for peripheral stations quarters and their shrinking importance as mobility nodes when the level of service is declining.

So, both from a historical point of view and looking at current spatial and mobility planning practice in Flanders, the development potential of regional public transport lines and the spatial structuring impact they have on their surroundings become apparent. A third confirmation of this potential can be found by looking outside of Flanders. Although the spatial and societal context is not always comparable to Belgium, the projects mentioned in the introduction – Randstadrail, the T2 and T4

⁹ Structuurversterking Stationsomgeving Vlaanderen-Nederland. For more information:

<http://www.grensregio.eu/2011/02/15/structuurversterking-stationsomgeving-vlaanderen-nederland/>

¹⁰ A full list is available at: <http://www.standaard.be/extra/treinen/?mobile=n>

trams in Paris, the Tram-train in Mulhouse, the Atlanta Beltline – show promising results of a qualitative upgrade of regional train lines into light rail, and the spatial impact it can have on the surrounding territory.

The concept of heavy rail transformation fits within a philosophy of optimizing the existing infrastructure networks, strengthening its ties with existing urbanization patterns, rather than adding new lines to a landscape already saturated with infrastructure. In the Netherlands, the potential of an optimization of existing mobility network infrastructures was studied in the BESTNET project (Rutten, 2011). All infrastructure networks were considered, yet a strategic advantage of public transport is explained through the ‘Wegener Circle Concept’:

Good accessibility can lead to the development of new homes and businesses. The use of land then results in activities at that location, which then leads to even more mobility. This in turn has an impact on accessibility and so on. If this increased mobility involves cars, it can cause congestion, as a result of which the location and accessibility deteriorates, causing urban sprawl. In the case of public transport the opposite can occur: increased use of public transport can lead to higher frequencies and increased quality, creating a self-reinforcing system. (Rutten, 2011)

The aim of a research by design on heavy rail transformation, is to detect spatial opportunities on which such a dynamic could graft itself.

3. ORDERin’F: a scenario-based research by design

Heavy-to-light rail transformation benefits from existing infrastructures, and as such offers a feasible implementation of light rail. However, other strategies are also possible. Within the ORDERin’F research project (OSA, 2009), the structuring potential of three different concepts for light rail connections are tested on a specific sub-region of Flanders; Klein-Brabant, situated in between the main cities of Brussels, Antwerp and Ghent. In comparison to the usual discourse on Transit Oriented Development (Curtis, 2009; Dittmar, 2009), the emphasis is on a qualitative and design-oriented approach, rather than a quantitative exercise in densification.

On a basic level, a regional public transport network aims at significant economic, social and environmental benefits for the society at large. However, the ORDERin’F research also projects such a network as a lever to restructure the suburbanized spatial structure of Flanders in the long term. This ambition brings about a complexity in – sometimes contradictory – objectives that is also present in realized projects throughout Western Europe and elsewhere. The most interesting of these ambitions are positioned on the intersection between spatial planning and public transport planning. The main domains that the research by design is dealing with, are infrastructure planning, mobility planning and spatial planning. Corresponding to each of these, a design concept is determined that functions as a scenario, focusing

on the specific issues of this domain (Figure 1). These scenarios sharpen the consequences of design choices, and clarify the way in which decisions on a larger scale influence the small scale level.¹¹ The scenario of heavy to light rail transformation corresponds to the infrastructural component of the research by design, and is elaborated in the next sections.



Figure 1. Three inputs for scenario building: existing infrastructure (left), existing mobility patterns translated into the bus network (middle), guiding landscape structures (right).

4. The region of Klein-Brabant as a laboratory for regional public transport experiments

The region within which this scenario is tested is the broader area around Klein-Brabant (Figure 2.). It is situated at the heart of the Flemish Diamond. Although it is the center of a highly urbanized region, the density is remarkably lower than the surrounding cities, its landscape qualities and natural values however are much less defined than the Green Heart of the Randstad conurbation in the Netherlands. Instead, Klein-Brabant is characterized by a direct and diverse juxtaposition of unbuilt landscapes, different types of housing tissue and areas of economical activities, strung together in a network of towns connected by ribbon development. As such it is exemplary for the Flemish landscape (Figure 2.).

A major driving force behind the dispersed urbanization in Flanders has been the sequence of consecutive infrastructure networks projected on the territory, on which diffused urban growth grafted itself (Van Acker, 2011). Although this process has

¹¹ The overall methodology is elaborated extensively in: Blondia, M., De Deyn, E. (2012). Understanding the development potential of regional public transport in a peri-urban context through research by design: the case-study of Klein-Brabant (Belgium). BUFTOD 2012 - Building the urban future and Transit Oriented Development. Paris, 16-17 April 2012.

The third scenario has been elaborated earlier in the research. For more information: Blondia, M., De Deyn, E. (2012). Landscape-based design strategies as a sustainable backbone for regional public transport in a dispersed territory. Landscape as a guiding principle in the transit-oriented transformation of Flemish urbanization patterns. ECLAS 2012 Conference, Warsaw, 19-22 September 2012.

been a work of centuries, planning and urbanism discourse have only recently, since the 1990's, challenged the dichotomy between urban and rural, through concepts such as sprawl, rurbanization, ville territoire, edge city (Delbaere, 2007). As such, the Flemish hybrid landscape is being recognized as a continuous nebula of urbanization, strongly interwoven with the open spaces in between. Hence the name 'nebular city'.



Figure 2. Klein-Brabant and the surrounding region, with the intersecting train connections highlighted.

A closer look at Klein-Brabant shows that the 'nebular city' offers specific challenges for public transport. As it is the far-out corner of three separate provinces (Antwerp, West Flanders, Flemish Brabant) and five public transport regions (Antwerp, Brussels, Mechelen, Sint-Niklaas, Aalst), the spatial and mobility challenges of Klein-Brabant are seldom considered on the scale of the entire region, in particular with regard to public transport. Because Klein-Brabant is enclosed by

these bigger cities whose transport networks intrude and influence the region, public transport in Klein Brabant lacks a logic of its own; it is merely an overlap of these different city-based systems.

The starting point for a research by design on the transformation of heavy rail lines is obviously the existing network passing through the region of Klein-Brabant. Mechelen was originally conceived as the central node in the Belgian train network. Although nowadays Brussels is the main hub, there are still many lines intersecting in Mechelen, most of them among the oldest lines in Europe¹². In the east part of the area lies the connection between Antwerp and Brussels, built in 1836. The line on the south edge of Klein-Brabant was opened just a year later in 1937. These two lines were part of the initial cross-shaped network projected on the Belgian territory. The other lines soon followed: in 1844 the connection between Ghent and Antwerp was opened, in 1856 a trajectory between Lokeren and Dendermonde was built, just west from the region of Klein Brabant. In 1870 a new diagonal intersected Klein-Brabant, connecting Mechelen to St-Niklaas. The last line to be realized was the line between Antwerp and Dendermonde, in 1880.

5. The dual concept of Belgian railways: a network of hybrid lines

All the lines intersecting Klein-Brabant were built in a period of merely forty years. As argued by De Block (2011), the Belgian railway network was realized as a comprehensive system covering the entire territory, conceived from the start as a carrier for national and transnational transport mobility, and at the same time as a tool for nation-building and territorial organization. These ambitions made the railway network into a hybrid scheme of engineering, spatial planning, politics and economy. This hybrid nature is also reflected in the trajectories of the train network. On the one hand, lines were planned as fast connections between the main cities or even between the neighboring countries. These lines were superimposed on the existing territory, their trajectories as straight as possible. On the other hand, the economical advantage that rail infrastructure brings to the context it cuts through, made a more subtle positioning of the trajectory desirable. Connections between cities deflected from a straight line to bring service to smaller towns in between, thus making the train a carrier for regional as well as inter-city mobility. On an even smaller scale, short branches of rail were often realized connecting individual plots of industry to the railway.

The function of rail infrastructure as a connector is thus of a dual nature: it connects the cities on both ends of the line with each other, while often also connecting the intersected territory to the national train network. These two different modes of 'connecting' are not mutually exclusive, nor are they perfectly complementary. As such, individual railway lines are not belonging to one of these two categories, but are always positioned somewhere in-between.

¹² Throughout this paragraph the building year refers to the date on which the part intersecting Klein-Brabant was realized, not the line in its entirety.

Since the conception and realization of the railway lines intersecting Klein-Brabant, the landscape has drastically transformed itself. Developments occurred around and because of the train network and its stations, while consecutive layers of infrastructures became attractors for activities in their own right. The interplay of the train network with the urbanizations and other infrastructures has led to complex spatial configurations. Taking the railway as a starting point however, three concepts of spatial development configuration can be derived (Figure 3.). In reality most lines show a combination of two or more of them, and hardly ever are they a clear and certified example of one concept. The next paragraph gives an overview of these configurations, after which they will be applied to the different lines intersecting the region, thus offering a base for design choices.



Figure 3. Three concepts of spatial configurations along regional railway lines: (1; left) train stations at a certain distance from town centers creating a dual centrality between both; (2; middle) parallel infrastructures attracting road-oriented development along the railway trajectory; (3; right) direct branches connecting individual plots to the train network.

- (1) Depending on how strong the interrelation between the railway and the intersected territory is, communities have stations at a certain distance from their centers. As the train was the fastest mode of transport at the time of its conception, a shift in centrality occurred in the local fabric of small towns. The station attracted all kinds of functions and activities, creating a tension between the historical center and the new center of mobility, being the station. In most cases this materialized into an axis connecting both, usually named 'Stationsstraat' (Station Street). Since the railway network and its stations have been built, the urbanization of the Flemish landscape has grafted itself on other infrastructure networks as well. Primary and secondary roads have, since the democratization of mobility by car, been strong catalysts for urban sprawl within the finely grained settlement structure of Flanders. Consequently, in the current situation, the structuring role that once belonged to the station is not always equally distinguishable. In many cases, the expansion of settlements exceeded the distance between town center and railway, filling up the void between them. In many towns, the railway acted as a barrier, with only limited urbanization on the other side of the station, with the expansion of towns taking place in other directions, thus further

away of the station. There are however exceptions: in Puurs, for example, the Keulenhoek quarter is located on the backside of the station.

- (2) The previous paragraph points out urbanization grafting itself on different infrastructure as a general concept, not specifically targeting the influence of one road in particular, but rather of the network as a whole. However, there are certain cases where a single infrastructure transformed the morphology of the urbanization, as the railway has done before. In particular, main roads and regional roads have attracted many developments. On the level of land use and morphology, these developments are confronted with the developments attached to or oriented towards the station. A fundamental difference between both, is the fact that train stations give way to nodal development, while road infrastructure stimulates linear development all along the trajectory. When projected on top of each other on the landscape, the resulting figure is a strip of linear road-oriented development, interrupted by nodal development around station locations. This occurs when segments of railway run parallel from main roads. The distance between the two infrastructure determines how strong the interplay between both is.
- (3) A particular case of railway-oriented development occurs when the line originally was not only intended as a connection between cities and towns, but also for the shipment of goods from the industrial developments it passes along. For this purpose, short branches of railway were built, establishing connections between the line and the industrial parcel. This gave individual companies or clusters of companies organized on one site, the opportunity of a fast access to the national and international rail network. As road transportation gained ground during the twentieth century, the strategic benefit of a rail-bound location became of lesser importance for companies. Most of these branches have been abolished or even demolished, and many of the industrial sites have become brownfields waiting for reconversion.

These three types of configurations overlap and influence each other in different ways along the railway lines intersecting Klein-Brabant (Figure 4, Figure 5.). A line-by-line analysis that focuses on these configurations offers a solid base for design choices and future development. This is explored in the next section.

6. Line-by-line: concepts for a light rail-oriented development

6.1 Railway 59 connects Ghent and Antwerp with an almost straight line. Two major curves are made to enter the two cities at its end, and in-between only two minor direction changes occur. Obviously, the trajectory was not chosen in favor of proximity to smaller towns within the Ghent-Antwerp corridor. Initially, only a few stations were built, in Klein-Brabant these are the stations of Sint-Niklaas and Beveren. Smaller towns started having their own stations along the line only later. As the line was not initially conceived as a connection for these towns, the line often passes at a considerable distance of the center. The one exception to this rule is

Zwijndrecht, whose center happens to be located near the straight line between Beveren and Antwerp.

As the railway serves mostly as a connector for the bigger cities along its trajectory, it doesn't have a strong link with the urbanized landscape it cuts through. It is a supra-regional infrastructure, and although it has had some impact on the local tissue around specific stops, the distance between towns and stations has often been too large to encourage densification. Rather it stimulated a low-density expansion of the town towards the station. As a conclusion from the past development of this corridor, the interrelationship between the trajectory and the intersected territory appears not strong enough for a regional light rail to be added to the rail corridor.



Figure 4: Map showing all the trajectories intersecting Klein-Brabant with the stations that were initially conceived in the concept of the line (big red dots) and those that were added later (small red dots)

6.2 A similar logic applies to the lines between Dendermonde-Mechelen and Antwerp-Mechelen. As part of the initial cross-shaped network projected on Belgium, they were as well conceived as (inter)national connections. The line Antwerp-Mechelen still has its supra-regional function today, but as the central node of the Belgian railway network shifted from Mechelen to Brussels, the line Dendermonde-Mechelen was downscaled to a regional connection. Although its course is as well an almost straight line between the two cities, it passes more closely near several town centers (Buggenhout, Londerzeel, Kapelle-op-den-Bos, Hombeek). As these towns expanded over the decades, their station and “Stationstraat” (the connecting road) attracted developments and became an integral part of the town. The towns that have their stations more remotely located (Malderen, Baasrode) still show a pattern similar to the towns along the Ghent-Antwerp line.



Figure 5: Map showing all the trajectories intersecting Klein-Brabant with all the branches that were built to connect individual plots with the train network. Additionally, alterations to the original line, such as taluses and separated intersections, were mapped (red).

Looking at the relation between these three heavy rail trajectories and other infrastructures, shows that while the lines Ghent-Antwerp and Antwerp-Brussels each have a highway running parallel at distance of approximately 4km, the line between Dendermonde and Mechelen only has crossing infrastructures. In the case of those first two lines, the parallel infrastructure is of a supra-regional character, similar to the train connection. Thus, the same cities are being serviced. In the case of Dendermonde-Mechelen, where such a parallel infrastructure does not exist, the string of stops along the railway line does not function as a corridor. Spatial relations and consequent mobility patterns have developed much more criss-cross, into a pattern that is equally diffuse as the road network. Whether a transformation of this regional train connection into a high quality lightrail connection can provide enough leverage for a transformation of the existing spatial patterns is uncertain. Spatial development potential around the existing stops is limited, as most of them have already been absorbed into the expanded town center, which implies a scarcity of unbuilt plots. On the other hand, entirely new stops for new developments are not desirable, as the areas where this would be possible are part of big, albeit fragmented, open space structures. Furthermore, this would require new road infrastructure as well.

The best opportunities for new developments along this railway line, exist around the more remote stations. These are well connected by both road and rail infrastructure, and there is still development potential around them. Many of these stations have closed because of low ridership, and reopening them requires the creation of a travelers potential that previously was not there. This has to be done by a mutually reinforcing strategy of providing good public transport service and stimulating mobility from and towards the stations by providing development opportunities. Thus, the strategy for this line is to encourage the existing principle of small station redevelopment, combined with a higher level of service by public transport.

The previous lines were initially conceived as supra-regional connections, and although the line between Dendermonde and Mechelen became a regional line over time, they have the according characteristics of being straight lines that are not intentionally connected to the intersected territory. The two lines that cross Klein-Brabant diagonally were originally planned as regional connections, and this shows clearly in the morphology of the line and its interaction with the surrounding landscape and urbanizations. They are the connections from Antwerp to Dendermonde and from St-Niklaas to Mechelen.

6.3 When the connection between St-Niklaas and Mechelen was opened all the towns within the corridor were provided with a station. Later, more were added as suburbanizations started to grow. The typical duality in development between station and town center, as elaborated in previous sections, made the railway an important connector along the corridor. Developments occurred in and around the towns and smaller settlements, with the railway stations as important node in the tissue. In-between these towns, there were some connecting ribbon developments, but these

were limited to their linear shape, and as such, developments were not homogeneously spread over the corridor between St-Niklaas and Mechelen. This changed however when the N16 was built parallel to the railway. This primary road was conceived with the intention of stimulating economical activity in the region. Since it was built, a lot of industrial companies and offices have located themselves along the N16. As the areas around existing towns and stations were already developed, available space for these economic activities was primarily found in-between these towns. The resulting morphology is a strongly developed corridor around the N16 and the parallel railway, in which concentric towns with station-bound developments alternate with road-oriented industrial sites. Not all of the landscape has been consumed by urbanization though, as the hydrological structure of the region imposes linear unbuilt spaces along the intersecting water streams. Also, along most of the trajectory, the railway has served as a barrier for economic developments, thus protecting the landscape behind it from expanding industries.

The spatial development potential along this line (Figure 6.) mainly exists in a restructuring of the industrial tissue. Currently, it makes inefficient use of the available land and its layout is completely oriented towards the N16. An optimization could enhance the importance of public transport in this area as an important area of employment, while at the same time a more efficient organization of the industrial sites could further stimulate development, realizing a layout that is more favorable in terms of public space.

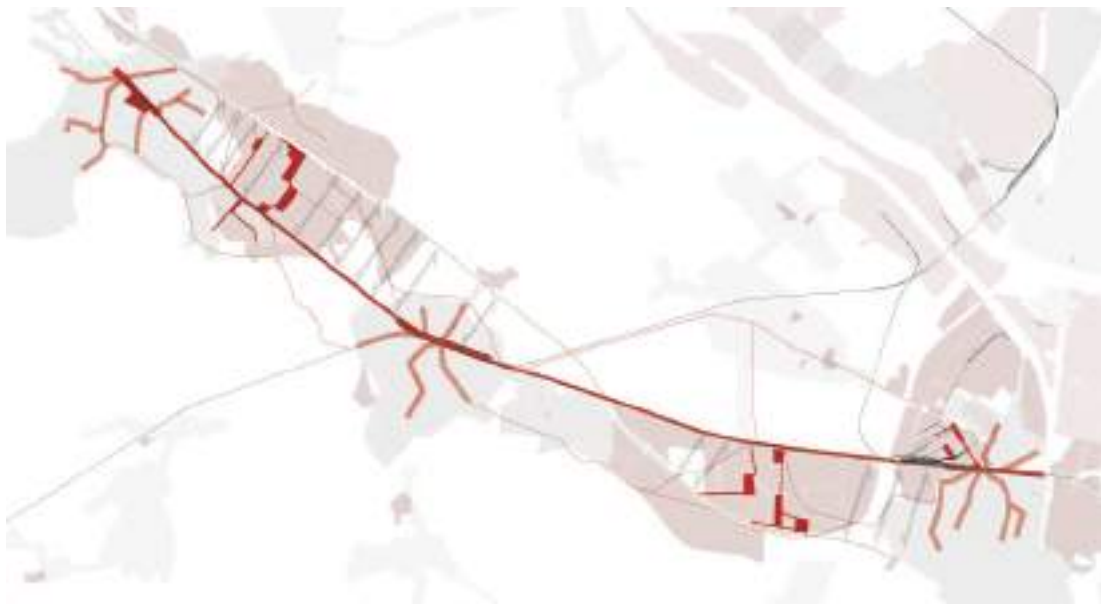


Figure 6. Development Scheme for the line between Sint-Niklaas and Mechelen (section: Bornem-Willebroek).

Within the town centers, main roads often connect in the vicinity of the station. Small-scale mixed-use redevelopment could occur on the long term along these axes. The railway bed in itself could also transform into such an axis, as a transformation of heavy into light rail softens the barrier of the infrastructure. Developments

currently have their backside oriented towards the railway, and the in-between space is strictly a residual strip that buffers the nuisances of trains. When light rail vehicles replace the traditional train cars, the rail trajectory can evolve into a public space, in which the infrastructure is integrated without imposing a strong barrier in the tissue. This new strip of public space could then become an attractor for redevelopment, changing the 'backside orientation' of flanking building blocks.

6.4 The line from Dendermonde to Antwerp has a regional character as well. There is a clear distinction between the sections Dendermonde-Boom and Boom-Antwerp. The first part of the line was built in a similar way as the line from Sint-Niklaas to Mechelen: with stations in or near existing towns with an intermediate distance up to a few kilometers. Between Dendermonde and Boom however, the railway trajectory never became an infrastructure bundle through the addition of a main road. This has resulted in very low spatial dynamics in this part of Klein-Brabant.



Figure 7. Development Scheme for the line between Dendermonde and Antwerp (section: Boom-Antwerp).

Most of the towns served by the railway have remained rather small and compact. In fact, as a consequence of its low dynamics, this section of the railway stopped its service in 1980. Currently it is exploited as a touristic steam train trail during the

summer months. Although a redevelopment of station areas could be possible along this section of the line, the desirability of a densification of this area is to be addressed with stakeholders, as this area has some distinct landscape qualities to preserve.

The section between Boom and Antwerp (Figure 7.) has more potential for a light rail transformation. It was also conceived as a regional railway with a strong connection to the intersected territory. Here there was already a particular water-based economic development at the moment the railway was conceived, thus creating a strong potential for this railway for the transport of goods. Big factory sites were connected directly to the railway by short private branches. These sites no longer have use of these branches, as most factories have either transformed into companies that don't produce goods, or have seized their activities resulting in brownfields waiting for redevelopment. In particular, near Boom, a number of clay excavation sites and old brick factories are a very specific type of brownfields. For most of these branches the railway infrastructure has disappeared, but the trajectory itself is still distinguishable in the landscape, as an unbuilt linear structure or as a boundary in the parcellation. All along the railway, redevelopment potential can be found in many of the plots at the end of old braches, either as redevelopment of existing businesses or as brownfield reconversions. The former branches can be reinstalled as pedestrian and bicycle paths, connecting a new development with a new station. This way, the development potential around the line not only exists in the immediate vicinity of existing and new stations, but also at the end of these connecting branches.

7. Conclusions

The research by design from which this paper originated has led to a number of conclusions. The main goal was to assess the spatial potential in the long term of a heavy to light rail transformation of existing railway infrastructures. First of all, not all railways are suitable for the installation of lightrail. The decisive factor behind this can often be traced back to the original nineteenth century conception of the railway. The extent in which it was conceived as either a supra-regional or a regional connector, largely defines its position in the current territory. The lines from Ghent to Antwerp and from Antwerp to Brussels show how straight connections were not meant to have a station in each town, which is exactly what a light rail would intend to do. The line Dendermonde-Mechelen was also conceived as a supra-regional connection. Coincidentally, many town centers happen to be in the vicinity of the straight line between the two connected cities. This is quite remarkable as there are not and never were any other parallel infrastructures stimulating a linear development between the two towns. The biggest potential for a light rail transformation however, can be identified for lines that were already conceived as regional connections in the nineteenth century. Their course was chosen as a balance between a fast – thus straight – connection and a line with proximity to existing settlements. These are the same characteristics that light rail seeks to exploit.

In terms of spatial elaboration of this development potential, the presence of parallel road infrastructures defines to a great extent the conditions with which the design has to deal. A primary or secondary road running parallel to the railway track is of great influence, as is the case between Sint-Niklaas and Mechelen, as well as between Boom and Antwerp. The corridor that is required for a well-developed light rail connection is already installed, but its morphology is not adapted to the nodal structure of transit-oriented development. Furthermore, the development potential along such a bundle is limited, as most terrains are already developed, due to the dynamics of the road infrastructure.

Where such a bundling with other infrastructures is not occurring, the desirability of new urbanizations filling up the landscape, as well as the feasibility of light rail in terms of mobility demands, are two main challenges. The mobility aspect will be calculated in the future steps of this research by design, through calculations with a newly developed traffic model¹³. The question of adding new developments in this landscape that are not well connected to the existing road system is a more complex matter, one that is much more subjective. As it is much more involved in the values and policy goals of various societal stakeholders, their opinions will be included in the elaboration of this topic. For this, the ORDERin'F project is developing socio-economic evaluation tools¹⁴. These are two important next steps in the research.

As the main goals of this paper was to emphasize the role of design in the ORDERin'F research, this track will also be further elaborated in the future. The options that were formulated at the meso-scale, will be explored and tested on a more detailed scale by the proposal of urban design schemes and development strategies on the local scale, highlighting the role of small scale stations as nodes of intermodality between regional and local mobility flows. As such, the role of design will be further explored in the matter of heavy to light rail transformation as a tool for urban development

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¹³ The research of IMOB within the ORDERin'F project focuses on this aspect, with the development of an activity-based multimodal traffic model.

¹⁴ The research of MOSI-T within the ORDERin'F project focuses on this aspect.

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