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Basic and Specialised Urban Fabric in Post-Industrial Reconversion

A Space Syntax Approach to the Pulp and Paper Mills and Towns in Quebec

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ABSTRACT

During the second industrial revolution (1880-1940), the pulp and paper industry in Quebec, as elsewhere in Canada, developed out of initial advantages that enabled industrial production, including the growth of new cities and neighbourhoods. From the 125 mills built from 1805 onwards, 62 mills remained in operation in 2011, a number that dropped by nearly 40% to reach 38 by 2020. The current relative decline of the pulp and paper industry in Quebec challenges the future of these specialised sites, their relative position, and their potential land use. This study aims to analyze the urban fabric using space syntax methods to assess the post-industrial reconversion of pulp and paper mills and towns in Quebec.

The case study concentrates on 16 paper mills located in 14 towns and cities in Quebec built between 1880 and 1930 (n=16, N=125). The methodology focuses on the degree of segregation of these settlements in a diachronic way. It foregrounds urban centrality, integration of the plant into the urban fabric, and the segregation of residential sectors. To better understand the urban planning models of Quebec cities, the paper meets two objectives. First, it involves analysing, comparing, and synthesising the spatial configuration of Quebec paper mills in both 1950 and today. Second, the morphological approach seeks the former case of the Canadian International Corporation (CIP) plant in Three-Rivers. Closed in 2002 and completely razed, the site still struggles, 20 years later, to integrate the existing city.

KEYWORDS

Pulp and paper mills, post-industrial requalification, urban segregation, syntactic analysis, urban planning

1 INTRODUCTION

1.1 The Relative Decline of Pulp and Paper Industry in Quebec

Between 1805 and 2020, a total of 125 pulp and paper mills were built in the province of Quebec (Gilbert 2015). During the second half of the 20th century, the number of active plants remained relatively stable, ranging from 59 to 65. However, since 2002, the number decreased; in 2020, only 38 remained in operation (Figure 1.1). The current relative decline of the pulp and paper industry in Quebec challenges the future of specialised sites, their relative position, and their integration into the existing basic urban fabric (Nadon-Roger and Dufaux 2020). The recent closure of a significant number of mills highlights the need to address the future of these brownfields in terms of urban planning, whether for new large industrial activities or integration into the adjacent urban fabric.

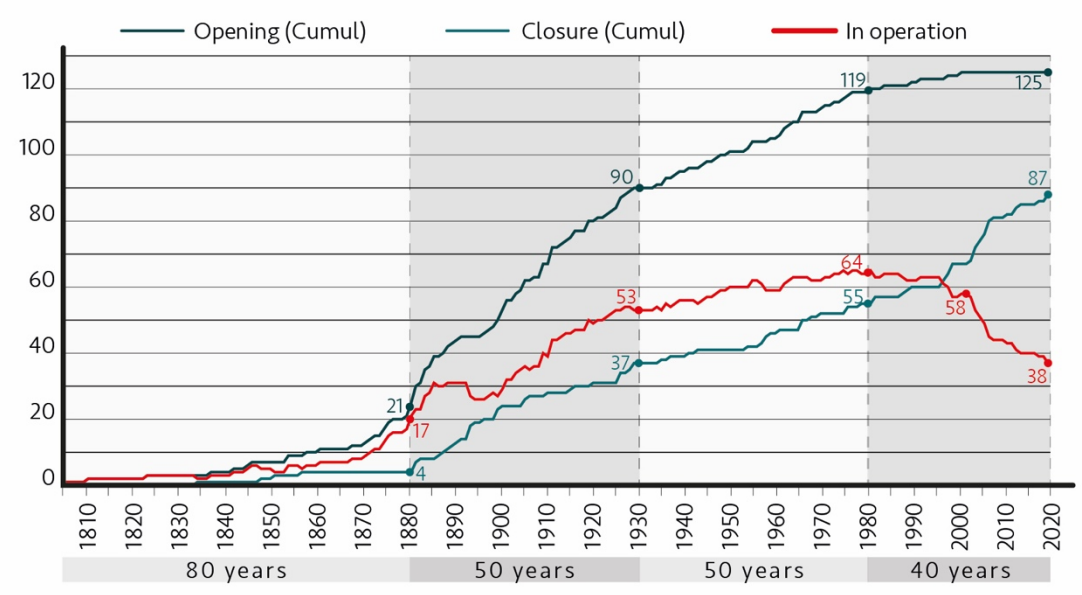

Figure 1.1 Changes in the number of pulp and paper mills in operation, cumulative closures, and cumulative openings in Quebec between 1805 and 2020 (based on Gilbert 2015 and actualised by the author).

1.2 Limits to the Traditional Urban Heritage Studies

This paper refers to industrial towns as human settlements created or consolidated to extract primary resources for exportation and economic purposes. Three examples of industrial cities were addressed by Fortier and al. (1996) – *Shawinigan, Témiscaming and Arvida* –, two of which are associated with the paper industry. They are cities planned at the beginning of the 20th century where urban development would be as controlled as industrial development. This control would be exemplified in different colonial development logic (King 1985): on the formal level, it is the expression of a modern way to produce; on the economic level, it is the enhancement of the capital return on the benefit of resources; and on the social level, it is a paternalistic form of domination of the company – *generally foreign* – on the local environment.

But what about urban form? What were the premises for the spatial structure of the city? How integrated was the mill into the urban fabric? Beyond the symbolic representation associated with working-class housing, to what extent the workers' and management residential precincts were distributed in the urban space?

More fundamentally, in a context where 41% of the paper mills in operation in 1997 are currently closed, what are the potential and limits of the requalification of post-industrial brownfields in relation to the spatial structure of their respective cities? What data can the morphological examination of these human settlement's genesis and transformation excerpt? How can spatial configuration principles inform the future of these cities and towns?

These questions may seem obvious from a Space Syntax point of view, but the literature specific to planning and urban history published in Quebec since the 1990s is oriented toward historiographical, economical, and social approaches. The research focuses on social history and the construction of archetypes linked to "progress" and "innovation": Arvida (Igartua 1996a, Morisset 1998), Riverbend (Côté 1994), Shawinigan (Lanthier and Brouillette 1990, Bellavance 1994) or Témiscaming (Trépanier 1996).

However, the morphological study of papermaking cities reveals that these cases were rather exceptional than a typical pattern (Nadon-Roger 2022). Although some of these studies address urban fabrics in their arguments (Bellavance and Guérard 1993, Igartua 1996b, Rousseau 2008), the urban planning, as well as the spatial configuration or the architectural choices are eluded in most of them. Moreover, the current state of these cities through their transformation process, or even their malformations, is not addressed.

1.3 A Contribution to the Post-Industrial Reconversion Debate

This exploratory work aims to analyse the genesis and transformation of the built environment. The methodology is based on the sequence "analysis, comparison and synthesis", and follows a progression through the description, evaluation, and design to fit in with the broad spectrum between "looking" at human settlements and "making" the built environment (Kropf 2017, pp. 8–9).

This paper has two main objectives. On the one hand, it involves analysing, comparing, and synthesising the urban configuration around the pulp and paper mills in Quebec. On the other hand, taking roots in a forward-looking perspective, it explores how Space Syntax analysis would inform future post-industrial transformations. The study aims to inform the transformation of the city through the understanding of the principles underlying the configuration of these environments.

The results are presented in three parts. First, the characterisation of the cities' urban fabric compares conditions in the post-war period with those of today. Second, the integration of urban fabrics bordering the mills is compared over a 70-year transformation. Finally, from one of the cases studied in the first two stages – *the former CIP pulp and paper mill in Three-Rivers* – we use Space Syntax analysis to illustrate the persistent urban scars despite the complete demolition of the factory and the promotion of a new residential district built on the previous industrial plot.

In conclusion, the results are discussed based on complex issues found in the literature about post-industrial reconversion projects clustered around urban barriers but bordering the oldest city core laying out residential basic fabric. The urban postulates of these specialised mono-functional sites were indeed centred on the factory, but when the industrial purpose is over and the relative position of the plot is of interest as a basic multifunctional space, its integration, its permeability, and its connectivity exert a considerable impact. Without addressing space configuration issues, these mega-plots would not be able to face actual and future urban, climatic, and social challenges. The conclusion confronts the deficiency regarding the urban form, its genesis and evolution as well as the patterns in street layouts, land subdivisions, and configurational logic of space in Quebec or Canada.

2 THEORY: SPACE SYNTAX ANALYSIS IN RESEARCH ON URBAN FORM

2.1 Configurational Approach to Urban Morphology

Notably, based on the work of Bill Hillier (Hillier and Hanson 1984, Hillier 1996), the configurational approach measures the road networks' impact on the accessibility of a specific location. It helps to underline the challenges of urban regeneration addressing the future use of the integrated and deliberately segregated plots within the context (Kropf 2017, p. 17). Together these measures offer a way to look forward to urban permeability.

As an important morphological tool, Space Syntax has been applied in a series of studies about the urban morphogenesis of brownfields. Tools are used to inform urban planning of brownfields lacking connectivity and intelligibility to link older parts of historical cities to the specialised, unpleasant, and derelict urban areas that lost their main industrial use (Kubat et al. 2012). Space Syntax has also leveraged complex urban systems in the context of major post-industrial shrinkage – *Detroit (Psarra et al. 2013)*. The Space Syntax can illustrate the relative position of plots and areas through the changes in time and configuration (Durmus and Kubat 2015). It is a dynamic and looking-forward set of tools.

2.2 Space Syntax Methods in Architectural Research in Quebec

The Space Syntax approach is relatively recent in the morphological study in Quebec. One of the contributions is related to the road system in Quebec City (Dufaux *et al.* 2013). The preference

for car mobility is induced by a road structure promoted for years by post-war public development strategies in favour of motorways.

At Laval University in Quebec City, three masters' degree theses in architecture were recently conducted focusing on different specific building components or configurations using Space Syntax morphological tools (Ruelland 2018, Tremblay-Lemieux 2019, Olivier-Cividino 2021). All studies used a mixed methodological framework from primary sources such as archives and historical cartography. They combined axial and segment analysis drawn from historical maps with a share of typo-morphology and programmatic configuration with permeability graphs. Also, three Ph.D. theses – *one in geography and two in urban planning* – studied Quebec's urban system using Space Syntax tools. They combined Space Syntax with other research traditions: land rent and capital accumulation theories *(Gilliland 2001)*, typomorphology in a diachronic and synchronic way (Gauthier 2003), the constructive traditions with socio-economic frameworks (Dufaux 2007).

We note a trend in Quebec literature toward the integration of the framework within mixed and interdisciplinary approaches to urban morphology, usually involving a share of typo-morphology and historical, geographical, or socio-economic analysis. Urban morphology remains a young research field in Canada (Gilliland and Gauthier 2006), as well as the Space Syntax tradition. It encountered social and cultural segregation that has been anchored in urban space since the beginning of the 20th century. The limited number of studies focusing on the integration and accessibility of urban fabrics reflects the importance given to social, economic, and political issues in historical research.

3 DATASETS AND METHODS

This study applies concepts established and previously validated in the literature – *urban centrality, integration, and choices* – to a current, complex, and understudied situation. The results are consistent with the fundamental concepts and methods proposed by Space Syntax. It contributes to generating an "operational history" (Muratori 1959), helping to guide present-day choices regarding what should be preserved, transformed, or built.

The spatial configuration analysis covers 16 paper mills, built between 1880 and 1930, located in 14 towns and cities (Figure 3.1). This 50-year framework targets mills built during the high growth period of the pulp and paper industry in Quebec (Charland 1990). This intentional sample (n=16, N=125) meets four criteria to ensure its representativeness: first, the year of construction; second, the availability of cartographic sources; third, the regional distribution representative of the historical one; and finally, a variety of urban and rural case studies (Nadon-Roger 2022).

The comparative analysis offers a diachronic approach to road systems between 1950 and 2020. It targets three characteristics specific to their general configuration: the urban centrality, the integration of the factory into the urban fabric, and the segregation of residential areas. Connectivity values are specific to axial maps and integration values to segment maps. The National Topographic Reference System (NTS) and the fire insurance atlases were used to redraw the old network and locate the public buildings to validate urban centrality. The relative position of the mills and the residential areas were also analysed from the old maps.

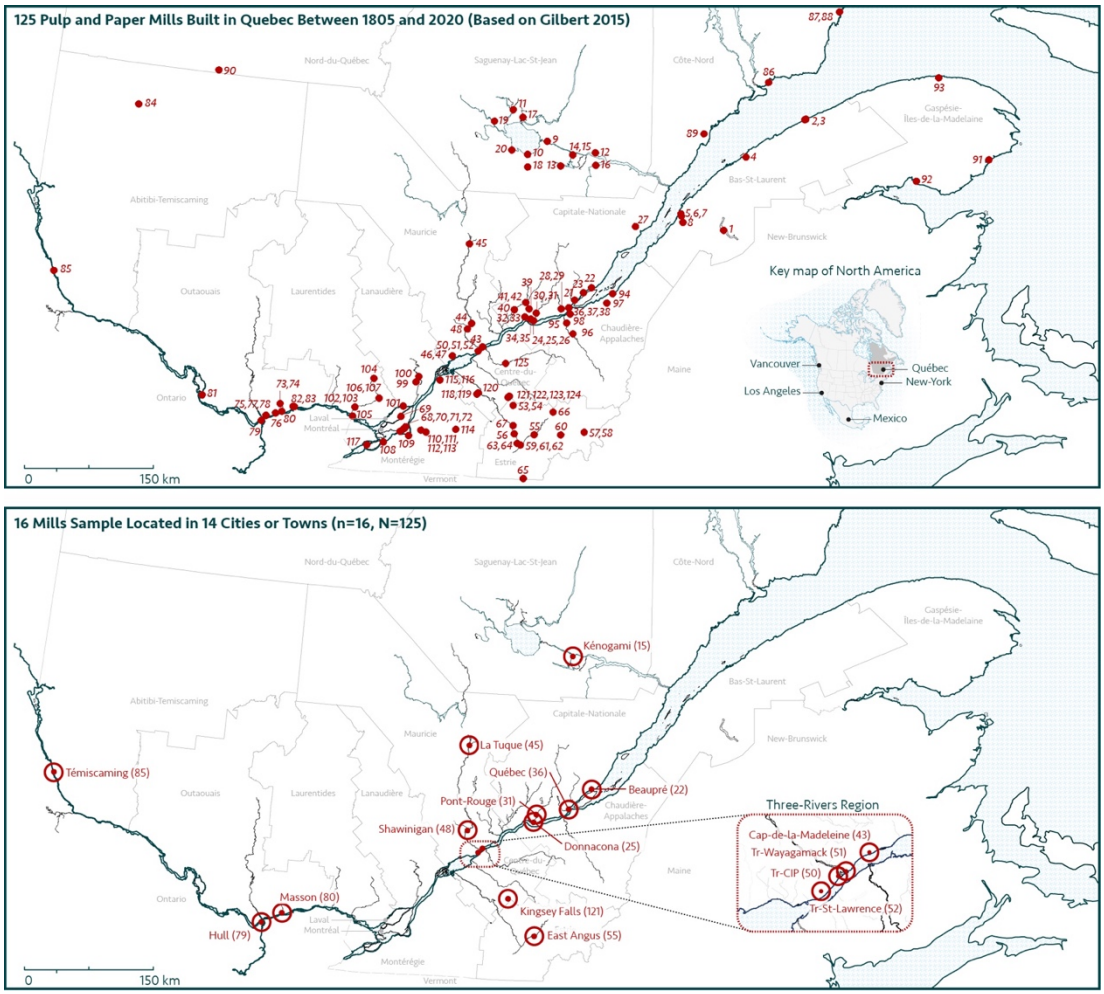

Figure 3.1 The top map shows the location of the 125 pulp and paper mills built in Quebec between 1805 and 2020 without concern for operational status. The bottom map indicates the distribution of the analysed sample. Every mill has been located and numbered based on Gilbert's historical survey (2015).

The urban fabrics are compared during the 1950s, that is to say within at least one life cycle after the construction of the mill – *more or less 30 years* (Brand 1995). It also corresponds shortly before the democratisation of car mobility and the expansion of post-war urban sprawl. All but one case – *Donnacona (1966)* –analysed between 1950 and 1960 based on the availability of archives. Models integrated into DepthMapX software cover a 1,600-meter radius around the mill.

The second part of the analysis still carries the first objective but isolates certain parameters in more specific ways. Again, in a diachronic manner, we focus on NAIN (normalised angular

integration) and NACH (normalised angular choice) according to a different analytical radii. It aims to understand the degree of integration through time between urban fabrics and the mill, from 1950 to 2020, using a radius of 400 metres, 800 metres, and 1200 metres.

The third part of the paper lays the foundations for a prospective reflection on the cases of post-industrial urban reconversion. Based on the case of the former pulp and paper mill of the Canadian International Corporation (CIP) in Three-Rivers, it focuses on the urban scars that persist despite the complete demolition of the industrial buildings on the site to be redeveloped.

4 RESULTS

Before getting into configuration measures, morphological data shows how urban fabrics grew over time. The road network has been developing, increasing in size and number of roads over the last 70 years (Figure 4.1). On the one hand, the network's length, and the total number of segments are comparable except for Kingsey Falls, Masson, and Pont-Rouge. Those towns were smaller than the average in 1950 and experienced a later development oriented toward car mobility in the second half of the 20th century. On the other hand, Hull, Quebec, and Three-Rivers experienced pre-industrial growth before the democratisation of individual car mobility. Moreover, the variation is roughly the same in terms of metres of the road (+31.4%) and the number of segments (+37.4%) and confirms that growth occurred at a similar road density from 1950 to today.

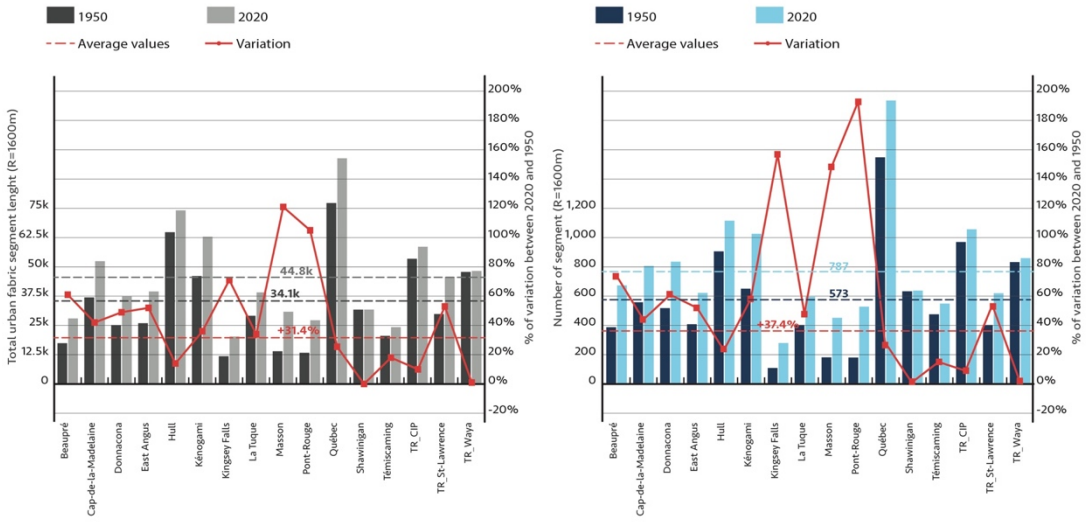

Figure 4.1 Graph showing the total road network length and its variation between 1950 and 2020 (left) and the total number of segments and its variation between 1950 and 2020 (right). For Quebec City, the values take in consideration the whole network within the 1,600-meter radius.

However, Quebec City poses its own set of challenges. The analysis does take into consideration the Limoilou and Maizerets districts, which are recognised as being working-class fabrics of the early 20th century. However, it also considers the central districts of the lower town – *Saint-Roch and Saint-Sauveur* –, which experienced earlier growth at the beginning of the 19th century, in addition to the 17th century historic centre of the city located on the top of the promontory. There

are obvious morphological differences in the road system density between those three fabrics. To this extent, for further analysis, Quebec City is the only case study that has been analysed from a model that neglects the previously defined radius of 1,600 metres. The urban fabric, still within the original radius, contains only the network located on the north bank of the Saint-Charles River and does not consider either the Saint-Roch and Saint-Sauveur neighbourhoods, or the historic centre. The whole model presents a distortion and drains the integration and choice of the historical centre due to the clear morphological variances. For the sake of the demonstration, Figure 4.2 shows the adjusted network length and the total number of segments of Quebec City.

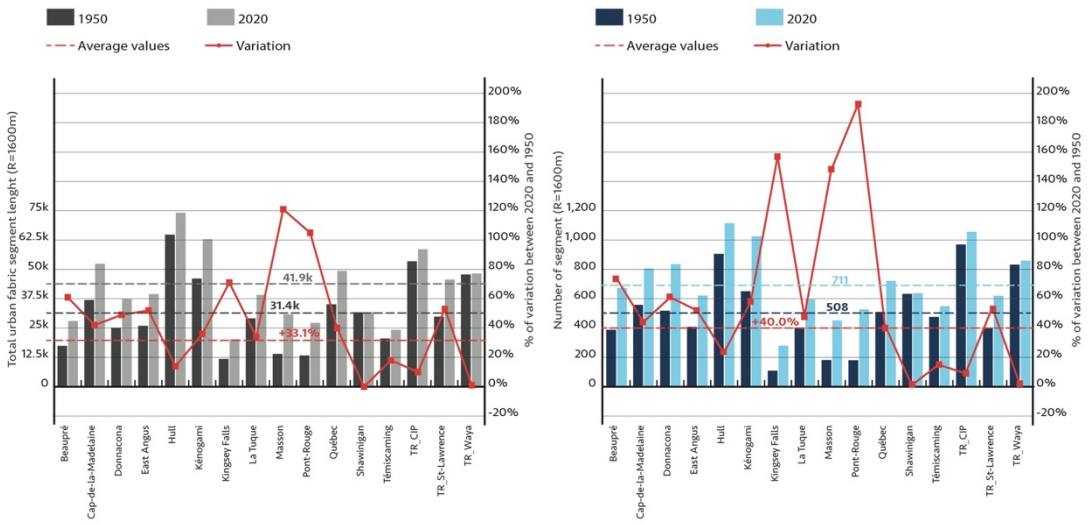

Figure 4.2 Graph showing the total road network length and its variation between 1950 and 2020 (left) and the total number of segments and its variation between 1950 and 2020 (right). For Quebec City, the values take into consideration only the north shore of Saint-Charles River.

4.1 Urban Centrality, Mill Integration, and Residential Segregation

First, the centrality analysis looks at recurrent building types and land use on the most integrated roads. The fire insurance maps note a concentration of institutions – *banks, post offices, churches, town halls, hospitals* – and public buildings – *schools, station, fire station* – located in very integrated segments in the 1950s. Generally built from masonry for life cycles of more than 30 years (medium to long), many of these buildings are still present on these historic routes.

Through the construction of bypassing roads and the development of highways, the integration of historical cores changed, particularly in the second half of the 20th century (Figure 4.3). Bypassing roads were created in the vicinity of 12 of the 16 studied cases, mostly between 1955 and 1975. This has contributed to a shift in commercial activity on these relatively peripheral roads, in parallel with the increase in inter-regional car mobility. Specialised buildings such as colleges, hospitals, and high schools built more recently also adopt a more peripheral location.

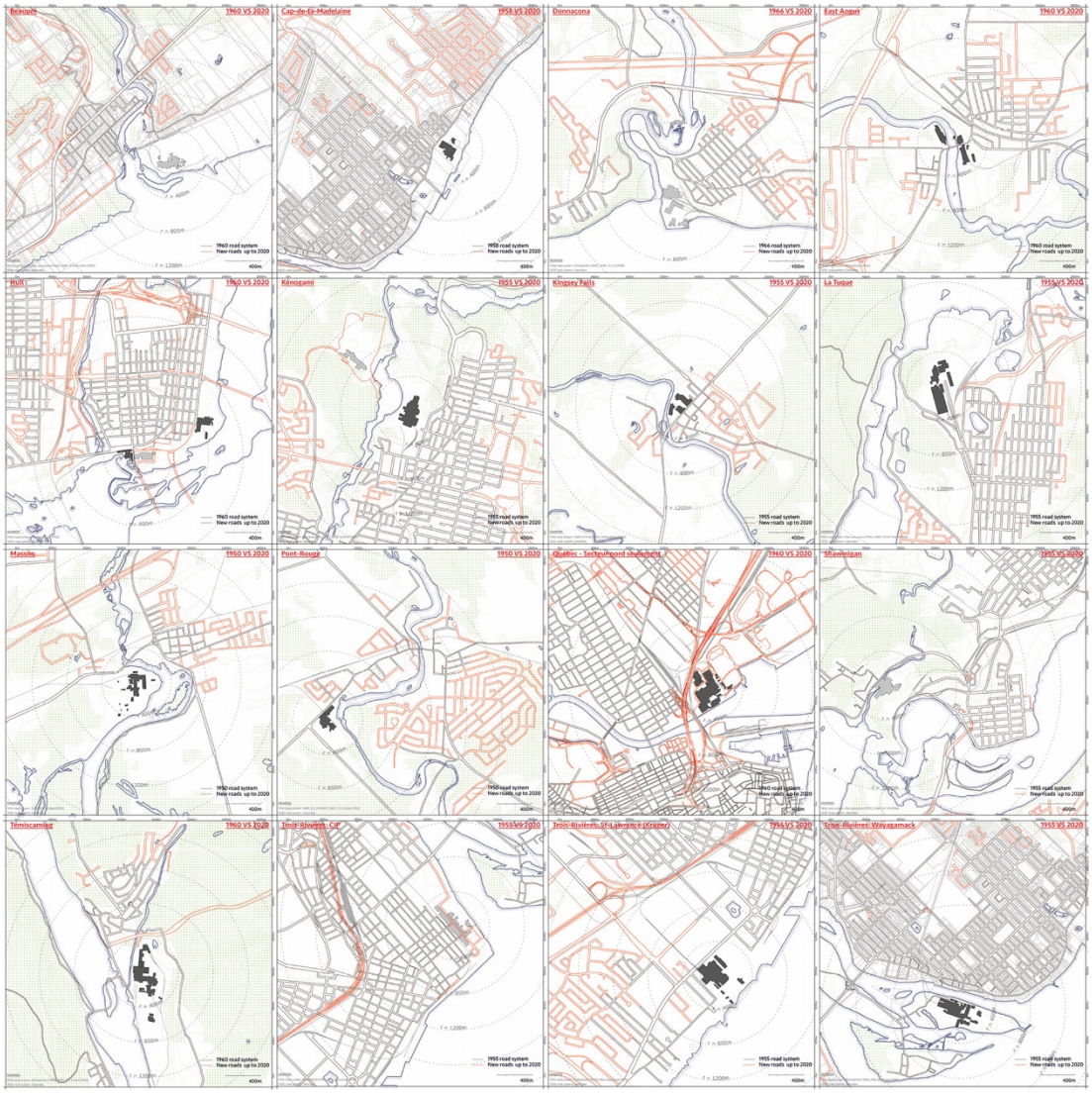

Figure 4.3 Maps showing road systems around the 16 studied mills by 1950 (in black) with new roads built up to 2020 (in red).

The spatial configuration of industrial establishments in 1950 shows that, despite their geographical centrality, the mills are segregated into the urban fabric (Figure 4.4). Despite the fact the mill is relatively central in each map, it is rarely located on a minimally integrated path. Geographically, all 16 mills are located within a 400-meter radius of the most integrated road but are connected to it by the most segregated ones. Access to the mills is generally strategically located in discontinuity with the urban fabric, whether due to the topography and river system required for the industrial process, or the presence of a railway for obvious exportation reasons. This shows the willingness of industrialists to dissociate productive activities from urban ones.

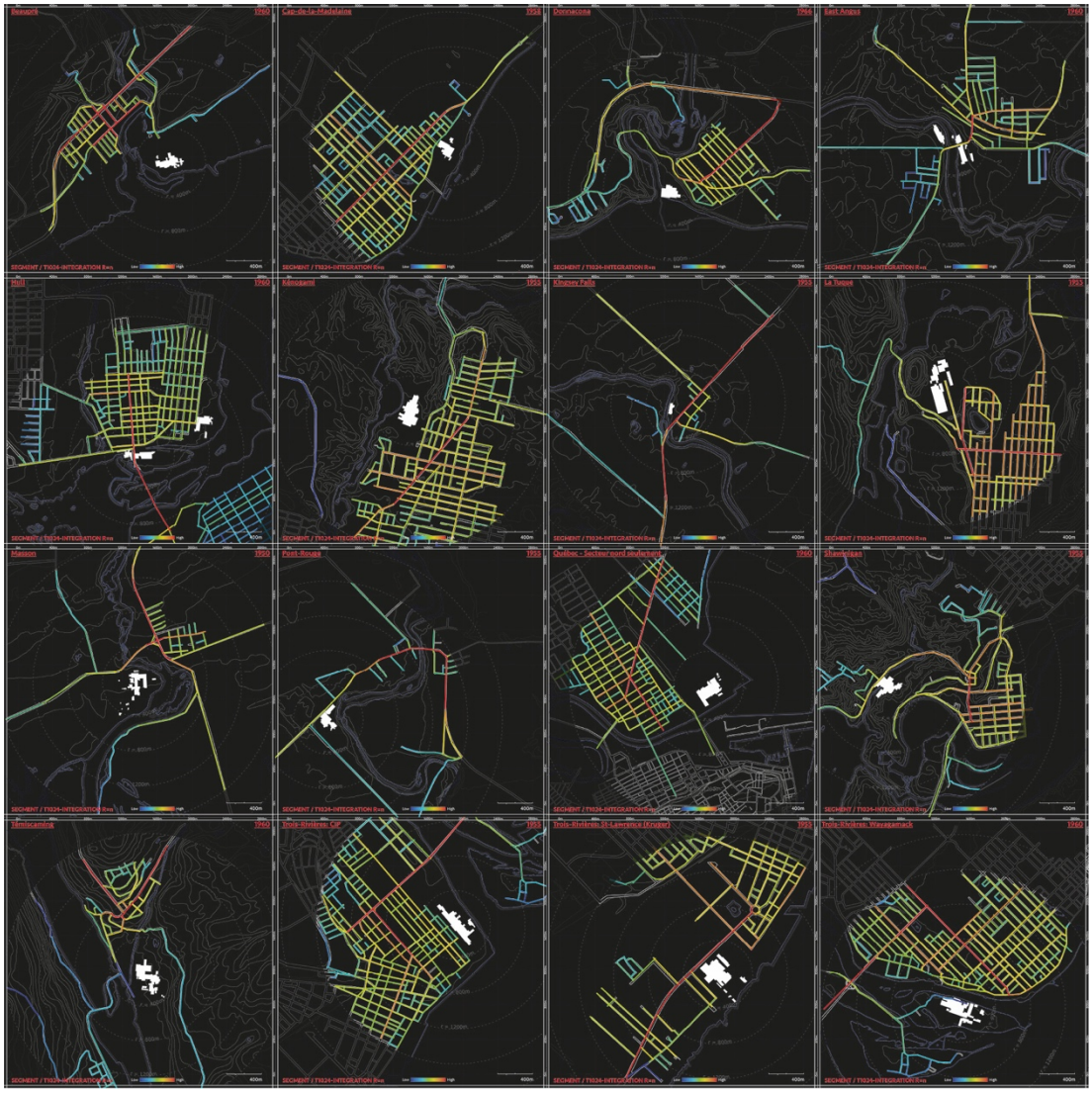

Figure 4.4 Graphs showing general integration (NAIN, R=n) based on the segment map analysis of the road system around 1950.

The exceptions are Hull, Kingsey Falls, and the St-Lawrence Mill in Three-Rivers. The E.B. Eddy Mill in Hull is located near the historic waterpower and on the only access crossing the *Rivière des Outaouais* to Ottawa until the completion of two main infrastructure projects – *Alexandra Bridge (1959) and Portage Bridge (1973).* In Kingsey Falls, the mill is located on the historic road, but with a large setback from the street, or rather very close to the stream. It is indeed segregated within its plot. In Three-Rivers, the St-Lawrence Mill is two kilometres East of the city core but still connected since rail public transport linked the mill to the downtown near the river mouth. The mill had very little impact on the area even 35 years after its construction.

In line with the results of accessibility to production sites, not all residential sectors are treated with the same degree of integration. For example, some streets and plots are located close to the mill but are not integrated. For instance, in Cap-de-la-Madeleine there are two residential areas located less than 400 metres from the mill but are completely disconnected from the rest of the urban fabric. The degree of integration of these two clusters is very low. Around the roundabout

to the south of the historic path, there are only five plots of very large dimensions, made up of detached single-family prestigious homes with views over the St. Lawrence River. Just a little North, we find an exceptional residential typology for the neighbourhood: townhouses. Only a few units are built there. It is possible to believe that this was a privileged place for company executives or guests. On the other hand, in the most typical and abundant fabric southwest of the factory, we find smaller plots with small suburban houses inscribed in a mixed fabric. The same pattern can be seen in Shawinigan and La Tuque as well.

The analysis of the 2020 road network shows that the specialised plots remain segregated despite the development of cities and towns (Figure 4.5). As the urban planning model of the last decades prioritises extensive peripheral developments, several industrial establishments are currently in a situation where the plot is surrounded by basic fabrics, but still morphologically isolated.

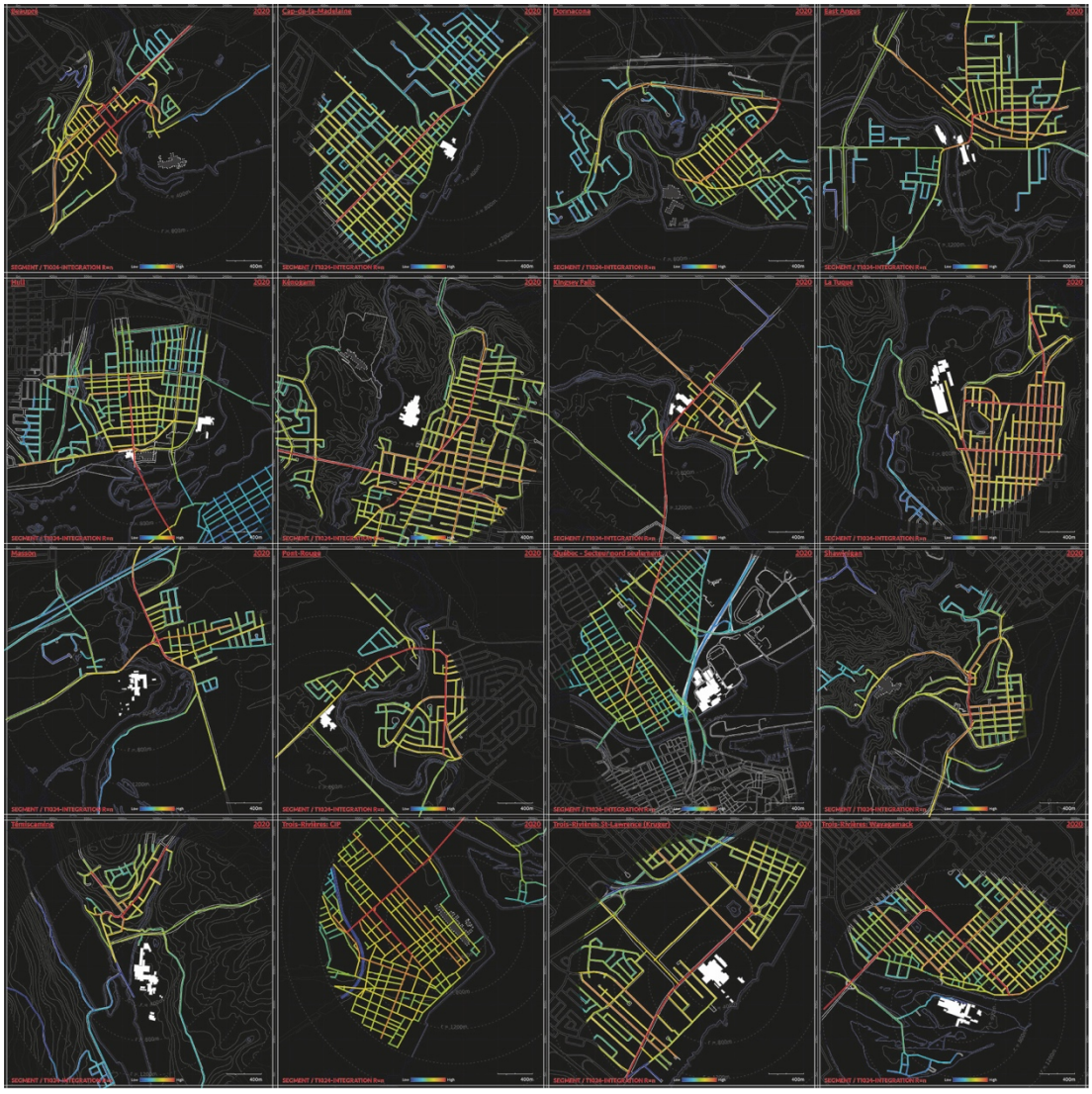

Figure 4.5 Graphs showing general integration (NAIN, R=n) based on the segment map analysis of the road system around 2020.

4.2 Correlation Factor Analysis

This second part of the analysis explores the comparison of case studies through the correlation between connectivity and integration as well as between choices and integration.

Axial Integration vs Connectivity

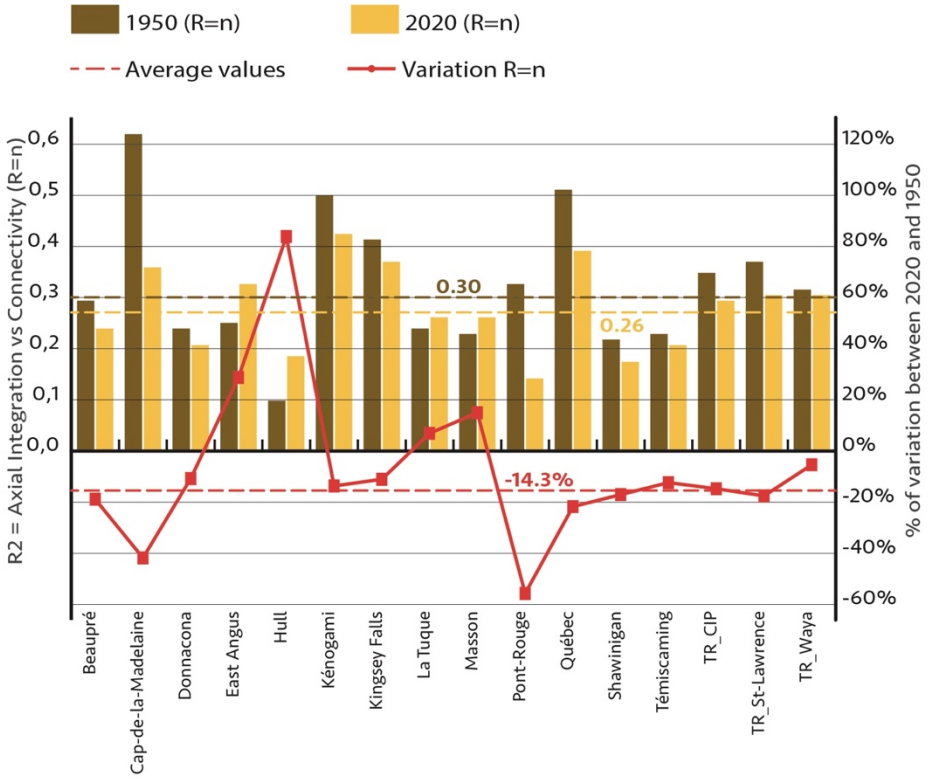

Figure 4.6 Graph showing correlation factor (R^2) between axial integration and connectivity (R=n) and its variation between 1950 and 2020.

First, axial maps show that in 75% of cases (12 out of 16), after 70 years of urban development, the correlation decreases between axial connectivity and axial global integration, namely the axial intelligibility (Figure 4.6). “The degree to which the number of immediate connections a line has is a reliable guide to the importance of that line in the system as a whole” (Space Syntax 2022). This spatial measurement shows the capacity to forecast the physical form of an urban layout easily.

The results confirm that urban sprawl weakens axial intelligibility and affects the capacity to read the whole from the parts. Spatial segregation strategies remain at the heart of urban planning; they respond to modern functionalism, the potential for sprawl linked to car mobility, and spatial and social stratification of separation. This is one of the paradoxes of the Welfare State which claims to integrate everyone into the middle class.

Segment Integration (NAIN) vs Choice (NACH)

Afterwards, by cross-referencing NAIN and NACH from 1950 and 2020, the general segment maps (R=n) reveal that in 62.5% of cases, the most suitable routes for use (NACH) are less and less integrated (NAIN) (Figure 4.7).

However, we see exception values especially in the case of La Tuque with a variation of +122%, while the average is -12.6% (R=n). Space Syntax explains that NACH values are a relatively formal representation of traffic flows within the urban fabric. Theoretically, this is the number of intersections to cross to reach a segment. However, this variable causes an exponential distribution due to the mathematical protocol that divides the value of the flow at each intersection. It is possible, especially in the case of R=n, that this causes eccentric values. These distortions can be calibrated by reducing the analysis radius. We can also put into perspective La Tuque variation because even with a 122% increase, its correlation factor remains the poorest of the sample with 0.075 while the average is 0.229.

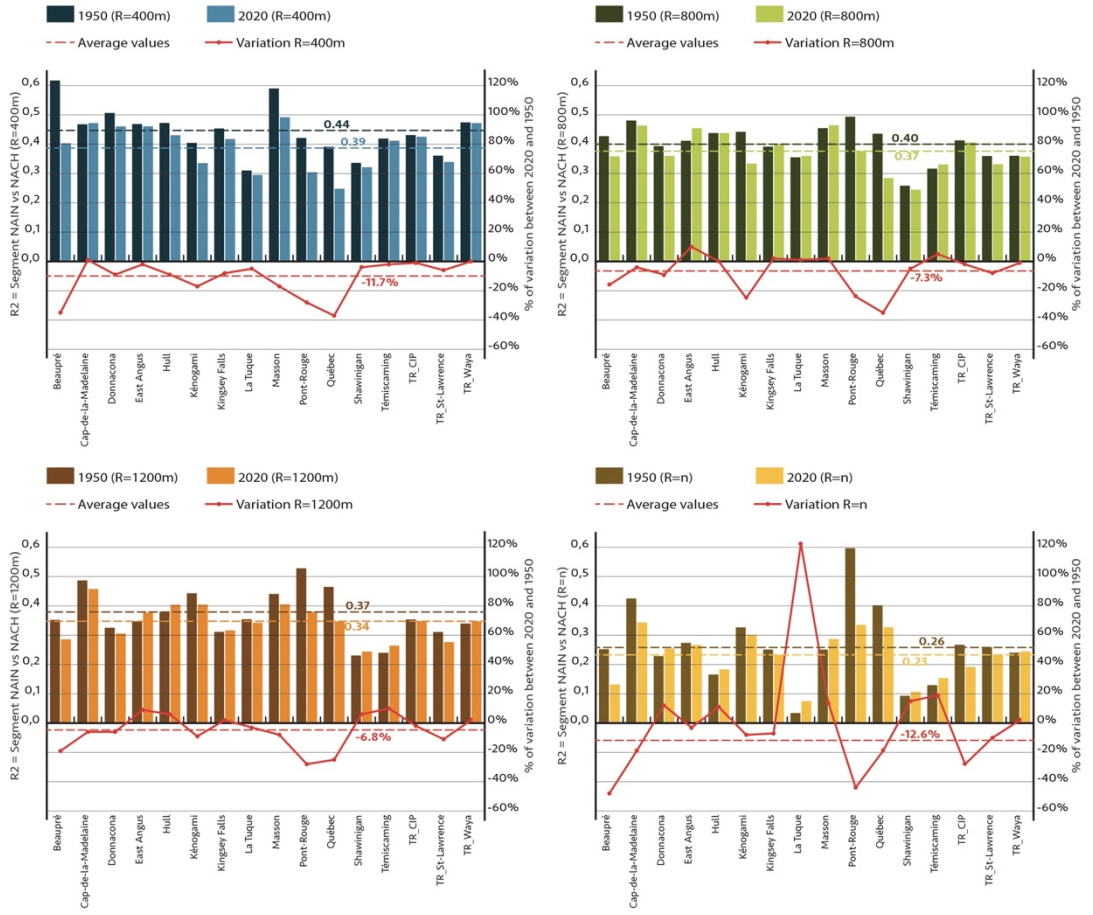

Figure 4.7 Graphs showing correlation factor (R^2) between segment integration (NAIN) and choice (NACH) and its variation between 1950 and 2020; R=400m (top left), R=800m (top right), R=1,200m (bottom left) and R=n (bottom right).

Nevertheless, this still supports the prior analysis of axial maps about the intelligibility of urban tissues undergoing extensive sprawl. Is it possible to draw other types of conclusions in relation to the different mobility used if we look at it from a different radii? Would urban sprawl be

viable only to the extent that it is structured according to a specific travelling mode? Can Space Syntax inform us about the premises on which the last 70 years of urban planning is based? The relations between the urban fabrics and the industrial establishment itself have been transformed over time, according to the transit modes highlighted by the period and the culture in force (Table 4.1).

Table 4.1 Potential mobility radius (Dufaux *et al.* 2013, p. 59)

Radius	***400 m***	***800 m***	***1.2 km***	***1.6 km***	***2.4 km***	***3.2 km***	***4.8 km***	***5.4 km***	***10 km***
Walk	5 min	10 min	15 min	20 min	30 min	40 min	60 min	72 min	125 min
Cycle		5 min		10 min	15 min	20 min	30 min	36 min	63 min
Car			5 min		10 min	15 min	20 min		42 min

First, at the pedestrian level – *within a 400-metre radius or a five-minute walk* – in all cases, the routes most likely to be used lost importance or remained virtually unchanged. This confirms that, since the post-war period, the development model advocated in the type of urban fabric, where the land has a marginal value and where space is abundant, is the spread of urban fabric and not the consolidation of pre-existing urban centres.

Second, the same is true within a radius of 800 metres, but this time, a few cases have slightly improved their score: East Angus (+10.5%), Masson (+2.2%), and Témiscaming (+4.6). In fact, Masson grew a lot, but in continuity with the pre-existing village fabric (Figure 4.3). Then, considering that the NACH value informs us about the number of intersections to be crossed to reach a street if it has changed very little since 1950, it means that the development on this scale has been very modest. As a benchmark, while the average increase in total network length is 33.1%, East Angus grew by 52.1%, Masson by 120.0%, and Témiscaming only by 18.2%.

Finally, within a 1,200-meter radius, only 5 out of 16 cases (31%) improved their correlation factor between NACH and NAIN. This represents a slight increase compared to the analysis at R=800m but does not help us draw clear conclusions.

As the analysis was performed from the road network contained within a 1,600-metre radius around the mill, we cannot rule about a significant threshold at which the correlation factor would rise with respect to a certain mode of transportation. We will discuss this point later in the conclusions. The next analysis isolates the segment integration data to deepen the spatial configuration reading.

What about NAIN value when isolated?

By isolating the maximum integration values (NAIN-Max), once the urban fabric does not reduce and streets are built, it goes without saying that the measures of general integration will increase.

Indeed, the NAIN-Max (R=n) increased between 1950 and 2020 in all cases (Figure 4.8). By breaking down the analysis with R=400m, R=800m, and R=1,200 m, several findings emerge.

First, only 6 out of 16 cases (38%) saw their NAIN-Max (R=400m) value going up: Cap-de-la-Madeleine (+3%), Kingsey Falls (+30%), La Tuque (+19%), Masson (+25%), Pont-Rouge (+54%) and Quebec (+5%). Except for Cap-de-la-Madeleine and Quebec, the increase in pedestrian-scale integration values affects cases that were the lowest in 1950. The small scale of those towns in 1950, and their late growth may partly explain why most of their maximum integration value (R=400m) has increased over the average (+5.3%).

Among these cases, Cap-de-la-Madelaine and Quebec saw their NAIN-Max increase by 3% and 5% respectively. These urban fabrics were already among the most urbanised in 1950, which would explain their modest variation. For the other four, increases are between 19% and 54%. Kingsey Falls, Masson, and Pont-Rouge are three settlements that retained their village character until 1950. In the case of Kingsey Falls, the plant remained modest until 1960 despite the construction of its plant in 1873. Development was organised when the Cascades company developed the city around a truck distribution in the 1960s. The Masson plant was built the latest of the sample (1930) while Pont-Rouge transformed its modest mill after the closure of the Portneuf-Station plant in 1936 moving the latter's equipment to a much larger new mill. Finally, the last case that increased its NAIN-Max (R=400m) is La Tuque. In 1955, the town was already a well-established urban fabric. Only one important new road is created to connect the neighbourhood near the pond to the rest of the older urban fabric to the east. This route seems to have played a great role in the integration between districts which was previously segregated.

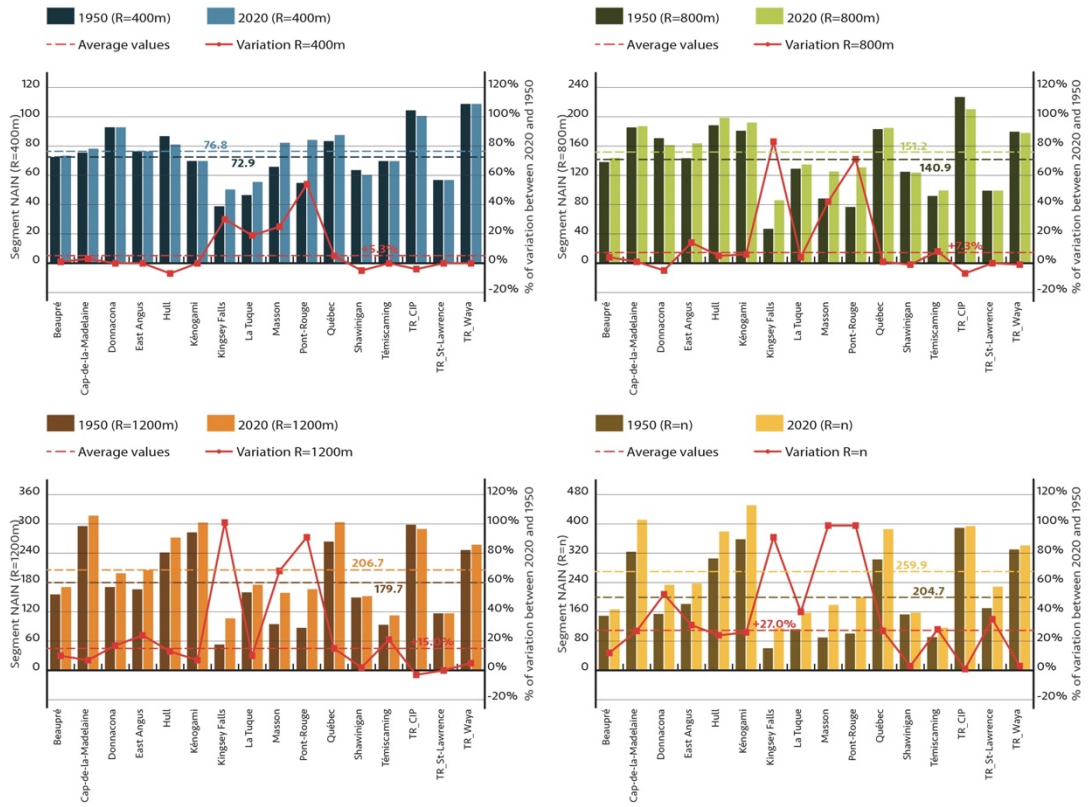

Figure 4.8 Graphs showing segment integration value (NAIN) and its variation between 1950 and 2020; R=400m (top left), R=800m (top right), R=1,200m (bottom left) and R=n (bottom right).

The NAIN-Max (R=800m) measures appear at first to have increased. In fact, it applies to the same cases as in the R=400m analysis: Kingsey Falls (+83%), Masson (+42%), and Pont-Rouge (+71%). East Angus (+14%) is added to the list.

In contrast, when looking at the results of the R=1,200m analysis, 13 out of 16 cases (81%) increased their maximum integration value. It is possible to travel 1,200 metres in a 15-minute walk, between 5 and 10 minutes by bike, and in 5 minutes by car (Table 4.1). Since almost half of cases have experienced an increase in their maximum integration value only from the 1,200-metre radius and larger, it nourishes a more generalised planning culture implemented since the 1950s.

Based on the findings of Anne Vernez-Moudon and al. (2006), a “walkable neighbourhood” would be contained within a radius of approximately 1 kilometre. The researchers demonstrate that to be perceived within a reasonable walking distance, services such as groceries, parks, and schools need to be contained within this close pedestrian radius. With the increase in integration values only from the scale of 1,200 metres or more, we understand that the past urban development promoted, and the current still promotes, extensive urban planning practices. From that scale and beyond, neighbourhoods become increasingly dependent on car mobility or any other means of locomotion that is not walking, as can be seen in extensive post-war peri-urban developments in North America. The consolidation of urban networks at the local level remains a marginal practice.

4.3 Post-Industrial Re-Conversion: Three-Rivers Issues

The city of Three-Rivers occupies a strategic geographic position at the meeting of St. Lawrence and the Saint-Maurice River. Founded in 1634, the city is located halfway between Montreal and Quebec City and quickly became a trading pole but saw its population grow slowly until the mid-19th century (4936 inhabitants). After 1850, numerous sawmills were built, which allowed the population to double in 1901 (9,981 inhabitants). The growth of the pulp and paper industry at the beginning of the 20th century significantly transformed Three-Rivers: the population was multiplied by 5 in 1951 (46,074 inhabitants). The mills were supplied with upriver quality raw materials upriver were served with abundant hydroelectric production, and enjoyed a privileged connection to the territorial export routes by train and by boat. Within a radius of 3,500 metres, three pulp and paper mills were built in 1920 and another in the nearby town of Cap-de-la-Madeleine in 1911. The Mauricie region experienced an unparalleled growth in paper production: in 1920, it had seven plants in operation among a total of 50 at that time throughout the province.

The recent relative decline of these industries has left derelict land in the heart of the city's central neighbourhoods. The Canadian International Paper (CIP), located on the riverside near the historic centre, is a case in point to illustrate the challenges of a post-industrial reconversion in an urban environment. It illustrates the challenges of urban fabric integration, connectivity, and permeability.

As a victim of the early 1990s pulp and paper industry decline and the first closure in 1992, the mill officially closed in 2000. All buildings were demolished, except for a warehouse near the riverfront that has recently been in use by the harbour authorities, and the filtration plant located on the edge of Saint-Maurice River. This last building was recovered in 2010 to house the Borealis Museum dedicated to papermaking in Quebec. In fact, the industrial site has been razed open was looking for a new development project, but remained fallow for nearly a decade. The *tabula rasa* did not liberate the site of the structural conditions specific to a segregated specialised industrial plot (Figure 4.9).

A major urban project entitled "*Trois-Rivières sur Saint-Laurent*" was launched by the city in 2007 around an exceptional public building. An open-air amphitheatre is built on the southwest tip of the site in close connection with the waterfront[1]. A group of private developers acquired most of the site in 2014 and proposed mainly residential buildings and secondarily a business centre. The plan enforces segregation and is very little restrictive in relation to the surrounding urban context.

[1] The project is the result of an architecture competition won by Montreal architect Paul Laurendeau.

Figure 4.9 On the left, an aerial photograph showing the CIP Mill in Three-Rivers in its early years in 1928 and its neighbouring urban fabric (BAnQ archives, notice 03Q_P600S4SS3P094-1928). On the right, a Google Earth view of the actual site shows the new amphitheatre on the waterfront and the residential buildings of "Trois-Rivières sur Saint-Laurent" project rising (Google Earth, 2021).

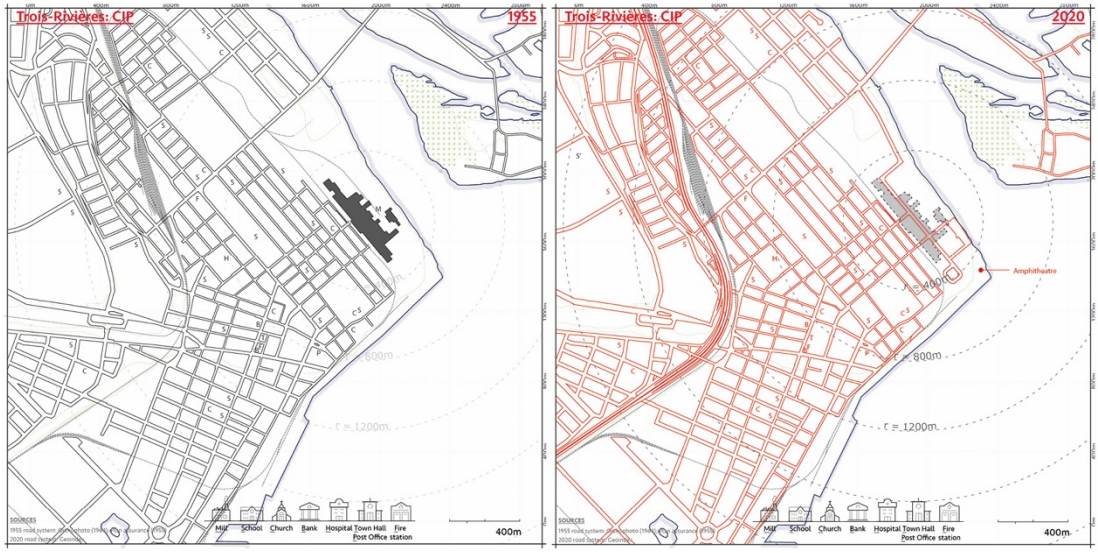

Figure 4.10 Maps showing the road system around CIP mill in Three-Rivers and its urban centrality in 1955 (left) and 2020 (right).

Today, two decades after the CIP's closure and the demolition of a significant part of Three-Rivers's industrial heritage, the site remains on the fringe of the city (Figure 4.10). As in the last century, the road network remains disconnected from the surrounding urban fabric. The waterfront didn't gain any legibility and stays as segregated from the public space. Urban and natural barriers – *the railway and the topography* – still divide the new development from the older central districts. The actual urban and architectural project neglects the relationship to public space. It underestimates the "15-minute city" basic concepts: proximity, diversity, density, and ubiquity (Moreno *et al.* 2021). The residential typologies advocated by the promoters, favour individuality, position the car mobility in the foreground in the public space, and leave little room for small local actors and entrepreneurs to be involved.

Space Syntax tells us that the previously mono-functional industrial plot had very low connectivity and integration in relation to the surrounding working-class district (Figure 4.11). The infrastructure barriers as well as the natural obstacles consolidate the impenetrable character of the site. During the 80 years of industrial use, the single access to the site through the Commissaires Street has structured the disconnection of the industrial activity and the residential environment. In fact, it is still today the only East-West access. Despite the new pedestrian link near the amphitheatre, the lack of connection crossing the railway maintains a similar spatial fragmentation to before. The proposal at the bottom of Figure 4.11 shows the connectivity potential from the moment we use urban planning tools to cross this railway barrier.

Secondly, using the bordering urban grid to create a site-specific road network, it is possible to reduce the size of the original mega-plot to make numerous smaller plots able to host the residential typologies found in older districts next to the project. By doing so, the suggested fabric also promotes an urban development strategy based on small-scale projects. In the interest of a variety of households, this kind of planning strategies allows competition and diversity in the land-use allocation, the building typologies, and the type of entrepreneurs charged to build the district.

Thirdly, it suggests turning a poorly integrated street into a bridge to the islands at the centre of the Saint-Maurice River mouth currently acting as a place of pleasure and swimming. It increases the connectivity to the economic city centre and create a new urban connector to Cap-de-la-Madeleine. Also, the segment map analysis shows the emergence of new urban polarities.

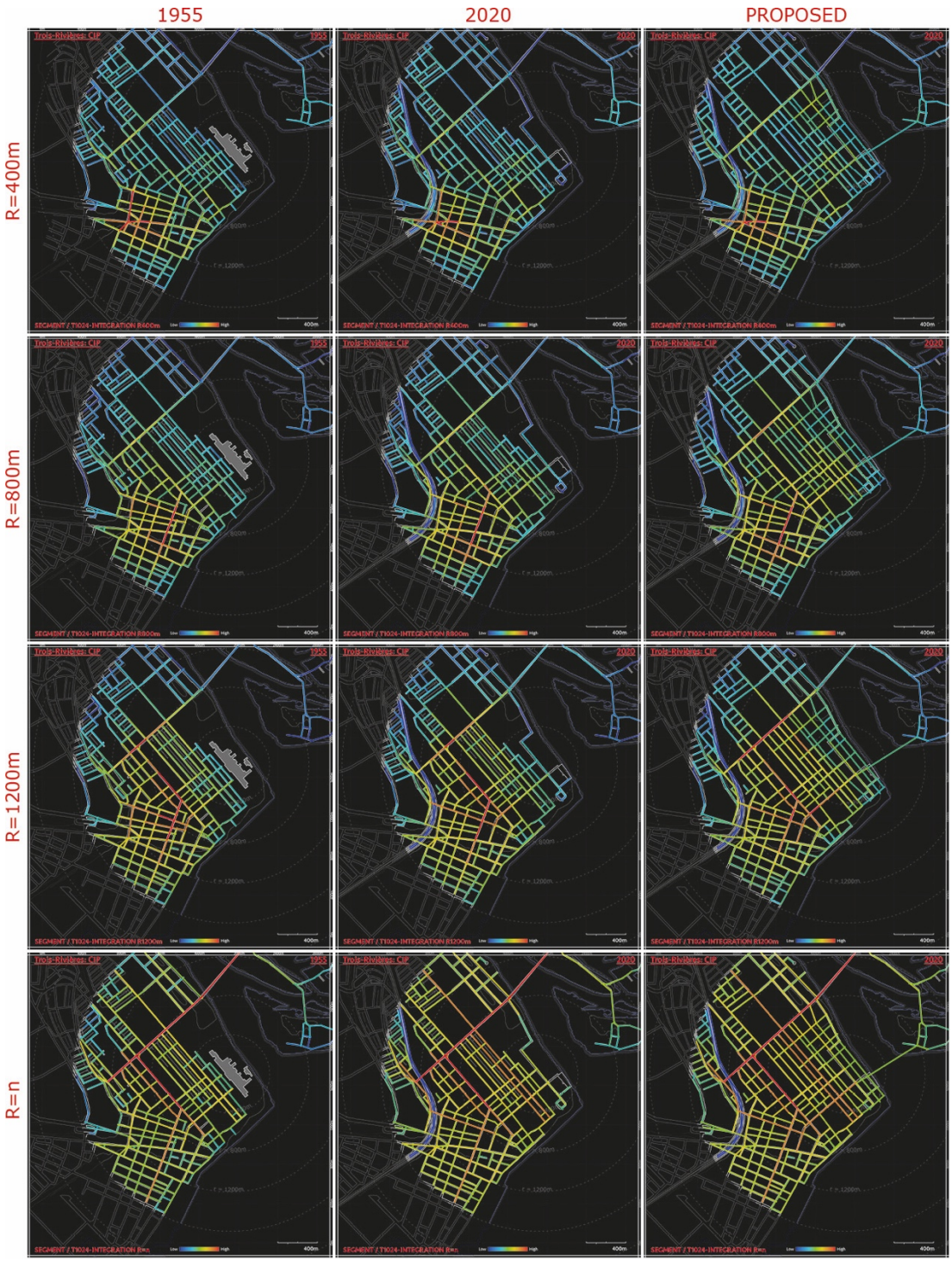

Figure 4.11 Graphs showing, based on the segment map analysis of Three-Rivers CIP Mill surroundings (1,600m radius), the normalised angular integration (NAIN) in 1955 (left graphs), in 2020 (middle graphs) and a proposed alternative (right graphs). The analyses are based, from top to bottom, on radii of R=400m, R=800m, R=1,200m, and R=n.

5 DISCUSSION AND CONCLUSIONS

> *Some predict that « 80-90% of architectural interventions in cities in developed societies will involve the rehabilitation or conversion of existing buildings, including a significant proportion of industrial buildings" [free translation] (Emmanuelle Real 2015, p. 66).*

This assessment should guide research, including the analysis and design of architectural and urban design solutions. Yet, little has been written about brownfield redevelopment in Quebec and elsewhere. The industrial wastelands become inherently urban because of their multiple-scale relationships within their surrounding built environment.

Since the 1980s in Quebec and Canada, the historical and socio-economic analysis have often sought to demonstrate heritage value by documenting exceptional company towns such as Arvida, Shawinigan, and Témiscaming (Fortier *et al.* 1996). Urban and architectural features had to be recognised, celebrated, and protected. However, as Gauthier (2003) demonstrated, the urban form is dynamic in time, witness to a given culture. The future of brownfields heralds the end of an economic and social order that inevitably translates into a dynamic evolution of culture and urban form. Now, without generalising the lack of integration between basic and specialised fabric found in this study to all industrial cities, it would be wrong to associate it only with specific cases. In fact, the urban form is the artefact of given material culture (Gauthier 2003, p. 9).

Observations on morphology and configuration suggest the existence of social practices relating to spatial segregation within urban planning strategies in the early 20th century. In addition, to characterise human settlements in their past form, the study informs us about characteristics that planners can use as tools to project the built environment coherently. Within an intentional sample representing 13% of paper mills built in Quebec since 1805 (n=16, N=125), spatial segregation is indeed a recurring parameter that structures the relationships between the industrial site and the urban environment, as well as the residential environments of bosses and workers.

How can these results help authorities and professionals to design and plan the reconversion of industrial brownfields? Understanding how these sites have been built and developed enhances the discussions about the genesis of Quebec's medium-size cities that grew in the first half of the 20th century. In fact, it questions as well how to plan the city of tomorrow.

In this last portion of the paper, we will first disclose urban challenges regarding the specialisation of sites to be redeveloped. We will secondly relate to governance and actors involved in those complex urban projects. Thirdly, the contribution to the early 20th century Quebec cities will be discussed, while we conclude with literature-based issues about the urban future.

5.1 Site Requalification: Addressing Natural and Anthropogenic Barriers

Since the 1960s, political, legal, and fiscal issues have limited the preservation and consolidation of cities' and towns' local built environment (Généreux and Dufaux 2019). Instead, they promoted urban sprawl and the development of new suburbs in rural areas. However, within walkable urban systems limited to a small 400-meter and 800-meter radius, the correlation between the most suitable routes for use (NACH) and the most integrated streets (NAIN) suggests that several urban centres and working-class districts still exhibit urban proximity qualities despite the systemic disinvestment noted earlier. From a built heritage point of view, the next generation of architects and urban planners will face many challenges in restoring those living environments.

At the same time, industrial sites remain effectively segregated. The preferred conversion strategy so far in Quebec is the demolition of industrial buildings leaving a bare and anonymous industrial wasteland while leaving the urban environment stripped of its founding industrial heritage. The cases of Beaupré, Port-Alfred, Three-Rivers, and Shawinigan illustrate this approach. The mills were razed under the pretext of urban incompatibility and high contamination rates, while the actual segregation of the plots was not addressed. In fact, the industrial plot and the urban fabric remain dependent, in a co-presence often unresolved, turning the wasteland of each other.

When reinvested by developers for speculative and real estate investment purposes, the sites are treated as isolated objects, blind to their urban context. The mega-plots which had previously well suited the specialised mono-functional purposes remain in the grip of structural conditions. The presence of natural morphological barriers – *topography and hydrography* – and anthropogenic limits – *railways, harbour, and transmission line* – near the site were typically implemented to support the site selection.

Although the relative position of many of these industrial plots is favourable to urban reinvestment potential, if both the natural and anthropogenic urban barriers are not addressed, if the plots remain segregated and the lack of permeability is not resolved, these brownfields will persistently experience spatial segregation with the surrounding city. The recent CIP urban redevelopment in Three-Rivers is a missed opportunity.

5.2 Interdependent Relationship to the Company to Be Reviewed

For municipalities, the importance of property taxes in the annual budget confronts a paradox regarding industrial sites. The White Birch mill in Quebec City shows that the property taxes paid by the company appear to be significant ($1.2 million annually in 2021), but the land and buildings value turns out to be twenty times less per square metre than the neighbouring residential districts (Gosselin-Giguère and Parent 2019, pp. 46–48). In fact, the average property

value of this industrial sector made up of the White Birch, the incinerator, and the Louise Basin, ranges from 16$/m^2 to 67$/m^2, while the average of neighbouring districts – *Vieux-Limoilou, Saint-Roch and Vieux-Québec* – ranges from 460$/m^2 to 1,500$/m^2.

Sometimes with a tax exemption or through the sale of land at preferential prices, the municipal authorities had established a special relationship with large corporations ready to invest locally in the late 19th century. In some cases, such as in Three-Rivers, public policies and property management were controlled by those who employed the majority, if not all, of the workforce, namely the pulp and paper companies.

As the mill vacates the urban landscape, leaving the site to be re-qualified, what is the relational model to promote between public, private, and community actors? Is it viable to perpetuate the earlier pattern where one major private investor takes over the entire site based on its interests, whether securing an industrial precinct or developing a speculative real estate venture?

To attract and serve a wider range of household types and various activities, how could we allow a more eclectic range of partnerships, and social and economic expectations? Would a plurality of smaller actors and investments support a more fertile relationship toward a more resilient living environment? After all, without facing the impact of spatial segregation, will the only one able to address these mega-plots be still the industrialists, but now involved in the "fourth industrial revolution" (Lasi *et al.* 2014)?

In the early 1980s, Pierre Bruyelle and Bernard Dezert (1983), both French geographers, already managed to discuss the risk of the dispossession of local decision-making power in the case of large-scale urban systems invested by large actors. In that sense, when facing the requalification of an urban wasteland, we can estimate it as a mistake to follow the same premises as a century ago based on large industrial, foreign funds, and new innovative technology promises.

Also, Federica Merzaghi and Malika Wyss (2009) demonstrate that those large projects are inevitably characterised by their difficulty to meet the local public action. They argue that to envision the right governance model for a successful reconversion project, it needs to match both multi-actors – *municipality, community groups, citizens, professionals, port authorities* – and multi-issues – *profitability, biodiversity, environment, urbanisation, gentrification, social inclusion, taxes, and jobs*. Swiss sociologists agree with France Dumesnil and Claudie Ouellet (2002) confirming how actors cooperate and agree on common objectives, defines the success of the rehabilitation project. They also corroborate the theory of the political scientist and sociologist Patrick Le Galès that "every city has its own governance" [free translation] (2004).

5.3 A Contribution to the Understanding of Cities in Quebec

This paper focuses on the morphology and configuration of 14 industrial cities developed through the 20th century. The observations suggest a larger analysis that aims to illustrate the nature of urban planning and spatial segregation across Canada. Nonetheless, this study outlines four main insights.

First, the divergence between general integration and axial connectivity shows a decline of 14.3% on average in the ability of users to easily understand and draw their own mental maps of the urban fabric. It decreased over time in 75% of cases (12 out of 16). Intelligibility decreases as the city spreads.

Second, the extension of the urbanised territory between 1950 and 2020 includes the construction of bypassing car-oriented streets. Although, most of the road system remained within the 1,600-meter radius which is accessible to pedestrians in a 20-minute walk. In fact, the shift of commercial activity on those peripheral streets has disvalued town centres and discouraged investments in old urban nodes. Instead, this phenomenon has encouraged urban sprawl and low-density districts.

Third, between 1950 and 2020, the general segment maps reveal that in 62.5% of cases (10 out of 16), the most suitable streets for use (NACH) are less and less integrated (NAIN). In fact, this general correlation (R=n) dropped by 12.6% on average. When deepen further, the correlation factor decreases by 11.7% in the 400-meter radius analysis, by 7.3% with an 800-meter radius, and by 6.8% with a 1,200-meter radius.

Finally, during the last 70 years of urban development, almost every studied industrial town has increased the relative integration in a radius equal to and greater than 1,200 metres around the mill, whereas the integration in the 400-meter and 800-meter radius remained virtually unchanged. This confirms that planning has been partial to 5-minute travel by car rather than on foot from the 1950s onwards. It illustrates a cultural paradigm of post-war planning when car mobility was the goal of state transportation policies.

These initial observations raise questions about mobility choices and modern urban culture. Incidentally, this invites us to a better understanding of the urban planning history of the late 19th and 20th centuries in Quebec that goes beyond the moral opposition between modernity and tradition, between established practices and progress theories. It suggests reading urban fabric beyond conventional representation-based heritage analysis. Urban studies should also address architectural choices, which would allow a new reading of density. Can the spatial configuration analysis feed a new measurement per network length rather than a human concentration per area? What about housing typologies that encourage different densities, that support different types of

public services? What are the correlations between the configuration of the road network, including its integration, land values, the built development of plots, and the adequacy between use and segregation?

5.4 The Need for a Culture of Integration

To this end, those observations confront the current challenges posed by urban concepts around the "15-Minute City" (Moreno *et al.* 2021). For those settlements whose mill closure makes the future uncertain, how to contribute to resilient planning "toward an ecology of urban form" (Romice *et al.* 2020)? It is relevant to the recycling of industrial urban brownfields (Nadon-Roger and Dufaux 2020) and above all, is part of a context where climate change and environmental externalities threaten the basics of urban space and the habitability of coastlines (Hein 2016). These broader analyses challenge several disciplines. Paul-André Linteau (1996) already explains at the end of the last century that Quebec is full of nuances and that rather rich conclusions could arise from opening up scientific practices.

The findings mentioned above suggest that morphologically speaking, road networks have been developing, increasing in size and number of roads in Quebec for the last 75 years. However, in terms of configuration, the form of these highly segregated networks persists. From a more theoretical point of view, everything suggests that a paradigm shift will have to take place to recognise truly the complexity that co-exists within forms and cities to develop the proper cognitive planning tools. In their very nature, cities are a complex adaptive system (Romice *et al.* 2020). Without being a substrate that allows other issues to operate, the urban form is a part of this complexity – so*ciety, economy, environment, culture, landscape, and architecture.* Regarding urban challenges complexity, the conversion of wastelands into sustainable neighbourhoods will first involve the need for a culture of integration that of reinvesting our old urban cores, that of consolidating existing networks. An approach that highlights the active history of the urban heritage of our towns and cities.

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7 APPENDIX

Every table shown in this appendix forecasts the variation between 1950 and 2020 road network configuration data: green means < 2%; yellow means between -2% and +2%; and red means > -2%.

Tableau 7.1 R2 = Axial integration vs Connectivity (Radius = n)

Mill	***1950***	***2020***	***Difference***
Beaupré	0.27	0.22	-0.052 (-19%)
Cap-de-la-madeleine	0.57	0.33	-0.240 (-42%)
Donnacona	0.22	0.19	-0.024 (-11%)
East Angus	0.23	0.30	0.067 (+29%)
Hull	0.09	0.17	0.077 (+84%)
Kénogami	0.46	0.39	-0.063 (-14%)
Kingsey Falls	0.38	0.34	-0.043 (-11%)
La tuque	0.22	0.24	0.015 (+7%)
Masson	0.21	0.24	0.031 (+15%)
Pont-rouge	0.30	0.13	-0.166 (-56%)
Quebec	0.47	0.36	-0.102 (-22%)
Shawinigan	0.20	0.16	-0.034 (-17%)
Témiscaming	0.21	0.19	-0.027 (-13%)
Three-Rivers_CIP	0.32	0.27	-0.048 (-15%)
Three-River_St-lawrence	0.34	0.28	-0.060 (-18%)
Three-River_Wayagamack	0.29	0.28	-0.016 (-5%)
Average	***0.30***	***0.26***	***-0.043 (-14%)***

Tableau 7.2 R2 = Segment integration (NAIN) vs choice (NACH)

	Radius = 400m			***Radius = 800m***			***Radius = 1.200 m***			***Radius = n***		
Mill	***1950***	***2020***	***Difference***	***1950***	***2020***	***Difference***	***1950***	***2020***	***Difference***	***1950***	***2020***	***Difference***
Beaupré	0.62	0.40	-0.214 (-35%)	0.43	0.36	-0.069 (-16%)	0.35	0.29	-0.066 (-19%)	0.25	0.13	-0.120 (-48%)
Cap-de-la-Madeleine	0.47	0.47	0.004 (+1%)	0.48	0.46	-0.017 (-4%)	0.49	0.46	-0.029 (-6%)	0.43	0.34	-0.082 (-19%)
Donnacona	0.51	0.46	-0.046 (-9%)	0.39	0.36	-0.034 (-9%)	0.33	0.31	-0.019 (-6%)	0.23	0.25	0.026 (12%)
East Angus	0.47	0.46	-0.008 (-2%)	0.41	0.45	0.043 (+10%)	0.35	0.38	0.030 (+9%)	0.27	0.27	-0.007 (-3%)
Hull	0.47	0.43	-0.042 (-9%)	0.44	0.44	0.000 (0%)	0.38	0.40	0.024 (+6%)	0.17	0.18	0.018 (11%)
Kénogami	0.40	0.34	-0.069 (-17%)	0.44	0.33	-0.108 (-25%)	0.44	0.40	-0.038 (-9%)	0.33	0.30	-0.025 (-8%)
Kingsey Falls	0.45	0.42	-0.036 (-8%)	0.39	0.40	0.006 (+2%)	0.31	0.32	0.005 (+2%)	0.25	0.23	-0.018 (-7%)
La Tuque	0.31	0.29	-0.015 (-5%)	0.35	0.36	0.005 (+1%)	0.35	0.34	-0.012 (-3%)	0.03	0.08	0.041 (122%)
Masson	0.59	0.49	-0.098 (-17%)	0.45	0.46	0.010 (+2%)	0.44	0.41	-0.035 (-8%)	0.25	0.29	0.036 (14%)
Pont-Rouge	0.42	0.30	-0.117 (-28%)	0.49	0.38	-0.117 (-24%)	0.53	0.38	-0.148 (-28%)	0.60	0.34	-0.262 (-44%)
Quebec	0.39	0.25	-0.143 (-37%)	0.44	0.28	-0.152 (-35%)	0.46	0.35	-0.118 (-25%)	0.40	0.33	-0.075 (-19%)
Shawinigan	0.34	0.32	-0.015 (-4%)	0.26	0.24	-0.014 (-5%)	0.23	0.24	0.014 (+6%)	0.09	0.11	0.014 (15%)
Témiscaming	0.42	0.41	-0.007 (-2%)	0.32	0.33	0.014 (+5%)	0.24	0.26	0.024 (+10%)	0.13	0.15	0.024 (19%)
Three-Rivers (CIP)	0.43	0.43	-0.006 (-1%)	0.41	0.41	-0.007 (-2%)	0.35	0.35	-0.005 (-2%)	0.27	0.19	-0.076 (-28%)
Three-Rivers (St-Lawrence)	0.36	0.34	-0.022 (-6%)	0.36	0.33	-0.028 (-8%)	0.31	0.28	-0.035 (-11%)	0.26	0.23	-0.027 (-10%)
Three-Rivers (Wayagamack)	0.47	0.47	-0.002 (0%)	0.36	0.36	-0.003 (-1%)	0.34	0.35	0.007 (+2%)	0.24	0.24	0.004 (2%)
Average	***0.45***	***0.39***	***-0.052 (-12%)***	***0.40***	***0.37***	***-0.029 (-7%)***	***0.37***	***0.34***	***-0.025 (-7%)***	***0.26***	***0.23***	***-0.03 (-13%)***

Tableau 7.3 Maximum segment integration value (NAIN-Max)

	Radius = 400m			Radius = 800m			Radius = 1,200 m			Radius = n		
Mill	**1950**	**2020**	**Difference**	**1950**	**2020**	**Difference**	**1950**	**2020**	**Difference**	**1950**	**2020**	**Difference**
Beaupré	73	73	0.85 (1%)	138	144	5.59 (4%)	155	171	15.27 (10%)	149	167	17.67 (12%)
Cap-de-la-Madeleine	76	78	2.64 (3%)	185	187	1.70 (1%)	296	317	21.35 (7%)	324	412	87.36 (27%)
Donnacona	93	93	0.00 (0%)	171	161	-9.33 (-5%)	171	199	28.19 (17%)	154	234	79.89 (52%)
East Angus	76	76	0.00 (0%)	143	164	20.32 (14%)	166	205	39.39 (24%)	182	237	55.84 (31%)
Hull	87	81	-5.67 (-7%)	188	199	10.19 (5%)	242	272	30.75 (13%)	306	380	73.45 (24%)
Kénogami	70	70	0.00 (0%)	181	192	11.26 (6%)	283	303	20.23 (7%)	358	451	92.89 (26%)
Kingsey Falls	39	50	11.56 (30%)	47	86	39.08 (83%)	53	107	53.67 (101%)	61	115	54.91 (91%)
La Tuque	47	55	8.94 (19%)	129	135	5.58 (4%)	160	175	15.67 (10%)	113	157	44.68 (40%)
Masson	66	82	16.46 (25%)	88	125	36.85 (42%)	95	159	64.27 (68%)	90	179	88.91 (99%)
Pont-Rouge	55	84	29.36 (54%)	77	131	54.21 (71%)	87	166	79.22 (91%)	101	200	99.31 (99%)
Quebec	83	88	4.13 (5%)	183	185	1.73 (1%)	264	304	39.73 (15%)	303	386	83.11 (27%)
Shawinigan	64	60	-3.18 (-5%)	125	124	-1.10 (-1%)	149	152	2.83 (2%)	153	158	4.88 (3%)
Témiscaming	70	70	0.00 (0%)	92	99	7.42 (8%)	93	113	19.22 (21%)	91	117	25.62 (28%)
Three-Rivers (CIP)	104	101	-3.75 (-4%)	227	211	-16.58 (-7%)	298	290	-8.46 (-3%)	390	394	4.83 (1%)
Three-Rivers (St-Lawrence)	57	57	0.00 (0%)	99	99	0.00 (0%)	117	117	0.00 (0%)	170	229	58.69 (35%)
Three-Rivers (Wayagamack)	109	109	0.00 (0%)	180	178	-1.78 (-1%)	247	258	11.13 (5%)	330	341	11.03 (3%)
Average	***73***	***77***	***3.83 (5%)***	***141***	***151***	***10.32 (7%)***	***180***	***207***	***27.03 (15%)***	***205***	***260***	***55.19 (27%)***

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