CAN WE RETROFIT SUBURBAN ARTERIALS? A MORPHOLOGICAL STUDY OF FOUR METROPOLITAN TORONTO CORRIDORS.

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ABSTRACT

The multi-lane arterial roadway designed for moving traffic is a central feature of post World War Two suburbs that challenges efforts to create more transit-oriented metropolitan regions. Yet, while retrofitting arterials remains an important goal, morphological research examining their prospects for transformation is scarce. Using morphological methods, we analyze four post-war corridors that cross parts of the Toronto region and that were developed under different planning regimes and in different geographic locations relative to central Toronto. The analysis demonstrates distinct changes in suburban corridor morphology across time and space. Findings include that the street-orientation of buildings declined as modernist planning ideas were more fully implemented, and then abruptly increased as New Urbanist ideas began to influence planning in the 1990s. Intractability to change, however, has steadily increased over time, with newer patterns of lots and development becoming more static. Given that general auto-orientation at a broader scale has not decreased, the implications for these new types of inelastic forms are not yet clear.

Keywords: suburban corridors, sprawl retrofit, Toronto, suburban morphology

INTRODUCTION AND LITERATURE REVIEW

This paper adds to the small literature that examines the morphology of suburban roadway corridors. It analyzes four corridors in the Toronto region developed during different periods of post-World War Two suburbanization and suggests that each has a particular urban morphology expressed in the types of building and lot patterns that line them. This has important implications for the prospects of retrofitting corridors into more walkable, transit-oriented places and, in turn, for larger smart growth strategies.

Although many cities and regions have adopted smart growth policies, many of their goals have proved difficult to achieve in practice (Downs, 2005; Grant, 2009). The existing literature looks to institutional, economic, and political reasons but gives little attention to suburban morphology. More focused on form is the literature on retrofitting suburbs. Tachieva (2010) examines suburban form across several scales and proposes design retrofits to create "complete communities," but pays little attention to the morphological constraints. In contrast, Dunham-Jones and Williamson (2009) and Williamson (2015) recognize the challenges of changing suburban form and look to large-lot, low-intensity commercial landscapes as places where more urban-scaled blocks, street, and building typologies can be introduced.

Scheer (2010) critiques such prototypical approaches, arguing that successful suburban retrofitting will require better understandings of underlying morphological logics. Using a roadway corridor that extends from central Cincinnati, Scheer classifies development on a spectrum of the likelihood of change, with small lot-residential areas seen as relatively unchangeable, large campus style

development such suburban malls as the most tractable to change, and areas with mixed lot and building types as in between.

We extend Scheer's approach, examining corridors developed across different decades in the post-WWII growth surrounding Toronto, Ontario. Useful here is Filion (2012), who uses a broad transect of suburban Toronto, sampling development from three distinctly different eras of planning, and analyzing whether newer planning regimes have been effective at changing the overall automobile orientation of suburban form. Our study picks up on these studies by looking at a middle scale. We look at the corridor level, examining development typologies and their potential for transformation like Scheer, but more similarly to Filion, we sample corridors developed during different planning eras and measure their general patterns of morphology and walkability (and by extension, transit orientation).

CASE STUDY AREAS

Suburban roadway corridors were selected to represent different planning periods and geographies. Based on previous studies (Hess & Sorensen, 2015), we used an iterative and inductive process to identify corridors that were relatively consistent in terms of the timing of their development and the planning models that shaped them. This was not fully possible, as many corridors were developed over long periods of time.

The following corridors were selected (see figure 1):

- *Eglinton Avenue East, Scarborough, (1950's and 1960's),* representing the transition from pre-war subdivision and development practices, to more planned post-war suburban models. Except for an industrial area originating as wartime munitions factories, development along the corridor proceeded incrementally with a mixture of auto-oriented retail, and modernist apartment complexes. Behind the corridor, most development consists of single-family subdivisions, roughly organized into neighbourhood units.

- *Finch Avenue East, Scarborough, (1970's),* representing highly coordinated planned suburban development under the Metropolitan Municipality of Toronto (Sorensen & Hess, 2015), a regional planning body, and the 1957 Scarborough Official Plan, which laid out grid of neighborhood units within the planned arterial road system, and a series of district centres with commercial areas and higher density housing. More detailed planning was implemented through secondary plans which shaped the layout of collector streets, schools and parks.

- *Winston Churchill Boulevard, Mississauga, (late 1970's into early 1990's),* representing a continuation and refinement of suburban planning models beyond the boundaries of the Metropolitan Municipality of Toronto. The area was shaped by two large corporate developments eventually incorporated into Mississauga official plans (Mississauga, 1976). Planning principles were similar to those for Finch, but with more inwardly focused neighbourhood units, more connected open space systems, and conventional retail centers at arterial intersections.

- *Burr Oak, Markham, (mid-1990's to present),* representing the adoption of New Urbanist planning models for greenfield suburban extensions. Planning occurred in conjunction with the development of Cornell, the largest, most fully realized New Urbanist project in the region with grid-like street patterns and higher than typical suburban densities (Xu, 2017).

Many of these ideas were also adopted in a set of secondary plans outside of the Cornell project. Only currently approaching full build-out, Bur Oak transverses these plan areas before turning south and crossing Cornell. Conceived as a new type of suburban roadway, Bur Oak features street-oriented development and areas that accommodate retail stores.

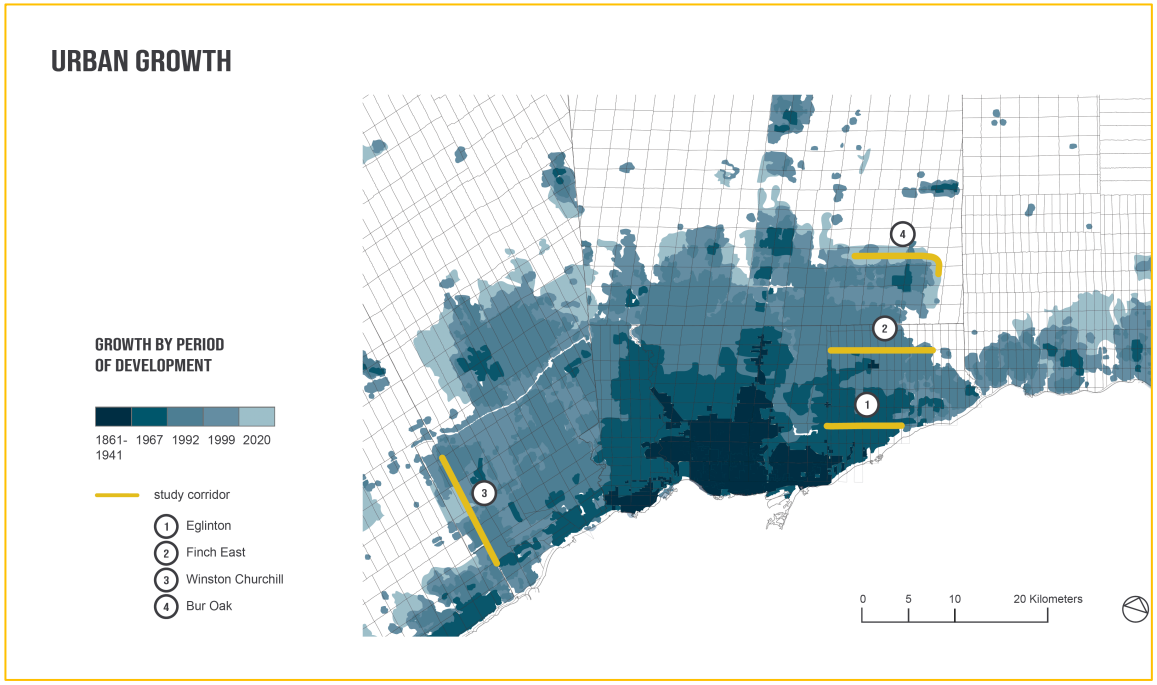

Figure 1. Case Study Corridors in Region with respect to Growth Periods

METHODS OF ANALYSIS

Two methods of analysis were used to explore and compare the morphology of the four corridors. One, "walkability" was measured using land use diversity (mix), population density, street connectivity, and the street orientation of the development typologies lining the corridors. Two, an analysis of redevelopment potential was created for commercial parcels along corridors based on parcel coverage and parcel size.

To analyze walkability we used common measures of land use diversity, population density, and street connectivity (Ewing & Cervero, 2010; Frank et al., 2010). To do so, we sampled points every 100 metres along each corridor, and measured across 400 metre diameter buffers in planning and transportation studies. This created a semi-continuous measure using the following:

- Land use diversity using a parcel-based data (Sorensen and Hess, 2015). A Shannon Diversity Index was used with parcels classified as commercial, residential, and institution uses. More equal distribution of area creates a higher measure of mix.
- Population density measured as people per hectare using 2010 Canadian census block data. Population for blocks that extended beyond buffer boundaries were weighted by the ratio their area within the buffer.
- Street Connectivity measured as the reverse of average block size for blocks intersecting buffers.

In addition, we created a unique index of building street-orientation for parcels fronting each corridor. This analysis draws on current urban design practice as integrated into performance-based zoning and emphasis on the importance of the street-wall in creating pedestrian-oriented streets. Measurement took place as follows:

- Parcels fronting corridors were analyzed and then classified by street orientation as frontage, semi-frontage, side-frontage, set-back, and reverse-lot types. Parcels without frontage (e.g. undeveloped lots and parks) were treated as anomalous types and not measured. See figure 2.
- These were given a score from 1 for the least street-oriented (reverse lot type) to 5 for the most street-oriented (frontage type).
- Corridor scores were developed averaging scores for 200 metre buffers on the same sample points as used for the previous analysis. The smaller buffer size accords with the smaller scale at which street walls influence walkability (R. H. Ewing, 2013).

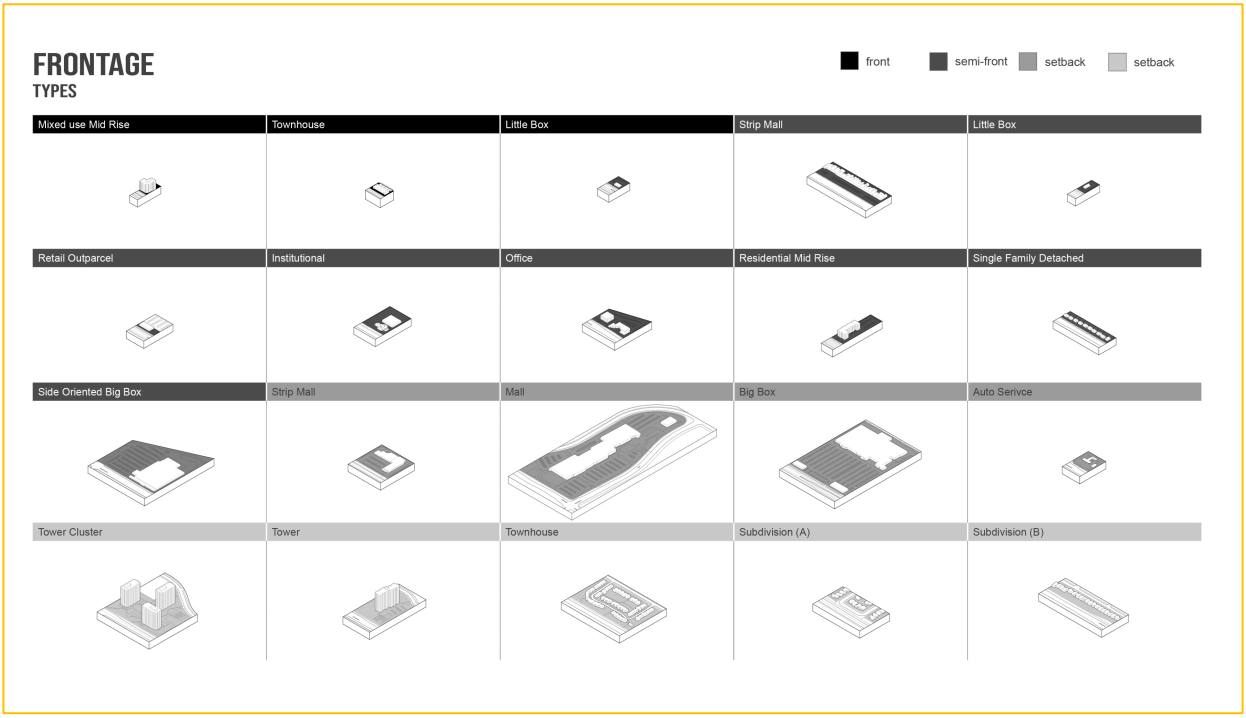

Figure 2. Corridor Typologies and Classification into Frontage Types

As a final step, all four measures were normalized on a scale of 0-1 using the combined data across all four corridors. Data form each measure was combined into a single index (mix + density + connectivity + street-orientation) for each sample point. These were spatially matched to each corridor and visually represented with a bar graph (Figure 3).

The second analysis examined redevelopment potential based on Tolentino (2011) relying on Scheer's (2015) concepts. Commercial parcels fronting the corridors were scored based on parcel size (1-5 with large parcels scoring higher) and building coverage (with lower coverage scoring higher). We depart from Tolentino in two ways:

- Tolentino also gives parcels additional base scores depending on types identified by Scheer. This double counts parcel size and coverage factors.

- We only apply scores to individual parcels, rather than large buffer areas, as parcels are the unit of (re)development.
- We only apply scores to commercial or employment parcels, as the redevelopment of other types is rare. Residential parcels in particular are often protected from redevelopment by zoning and other planning policies.

FINDINGS

Figure 3 presents the walkability scores for the four corridors. The following are summary findings based on median scores:

- Eglinton, the oldest, least planned corridor has the best overall walkability. This is driven by the highest median scores for land use diversity and density, followed by the second highest scores for connectivity and frontage.
- Burr Oak, planned as a New Urbanist Street, ranks next, out-performing the other corridors in terms of street-frontage, but with poor land use diversity and density (similar to Winston Churchill). Surprisingly, street connectivity, considered a defining characteristic of New Urbanism, is low because of large blocks associated with large open spaces and institutional uses.
- Finch East, highly planned to include district centres and apartments in the 1970's ranks next, with densities higher than Winston Churchill and Burr Oak, but with poor land use diversity and frontage overall.
- Winston Churchill preforms poorly on all dimension except connectivity, with poor density and land use diversity, and very poor frontage in particular. The connectivity score is surprising, but suggests this measure may not well capture walkability in these kinds of contexts where internal block structures may be relatively small and consistent, but have few connections to arterial-through streets

		Diversity	Connectivity	Density	Frontage	Index (Score Sums)
Eglinton	max	0.98	0.46	0.87	0.93	2.72
	min	0.02	0.05	0.00	0.40	0.56
	mean	0.62	0.20	0.47	0.63	1.93
	median	0.66	0.21	0.51	0.64	2.09
	St dev	0.25	0.10	0.27	0.10	0.55
Finch East	max	0.94	0.58	1.00	0.87	2.43
	min	0.00	0.00	0.00	0.20	0.36
	mean	0.41	0.20	0.42	0.39	1.41
	median	0.43	0.19	0.38	0.37	1.46
	St dev	0.29	0.15	0.26	0.13	0.56
Winston Churchill	max	1.00	0.62	0.50	0.85	2.21
	min	0.00	0.02	0.00	0.00	0.61
	mean	0.29	0.26	0.29	0.31	1.15
	median	0.23	0.26	0.30	0.26	1.08
	St dev	0.26	0.13	0.11	0.17	0.41
Burr Oak	max	1.00	1.00	0.47	1.00	2.72
	min	0.00	0.00	0.08	0.68	1.28
	mean	0.47	0.19	0.29	0.92	1.86
	median	0.43	0.10	0.30	0.95	1.82
	St dev	0.24	0.22	0.10	0.08	0.28
	St dev	0.24	0.22	0.10	0.08	0.28
All	max	1.00	1.00	1.00	1.00	2.72
	min	0.00	0.00	0.00	0.00	0.36
	mean	0.43	0.22	0.36	0.54	1.53
	median	0.42	0.20	0.33	0.48	1.64
	St dev	0.29	0.16	0.21	0.27	0.56

Figure 3. Walkability Scores

Figure 4 presents the data spatially and visually. The following are summary findings:

- There is great variation in the overall index and its constituent variables across and within corridors. The constituent variables do not have clear relationships between them in any corridor (also confirmed by statistical tests).
- Burr Oak has the most consistent overall walkability scores and Winston Churchill the most distinct peaks.
- The corridor sections with the highest scores occur on Eglinton in areas with relatively small-lot commercial that have medium frontage scores and higher densities generated by apartments, but poor connectivity, and on Burr Oak, where a conventional shopping centre exists, little conforming to New Urbanist principles, but increasing diversity.
- Finch has slightly lower peaks of walkability, largely occurring around planned community centres with higher densities and increased diversity, but lower connectivity and frontage.
- Walkability also peaks around shopping centres along Winston Churchill, between which land uses are almost all residential, densities are low, and there is little street-oriented frontage.
- The lowest walkability is in large areas with single uses (e.g. a large big-box retail area on Eglinton, and a large employment area on Finch).

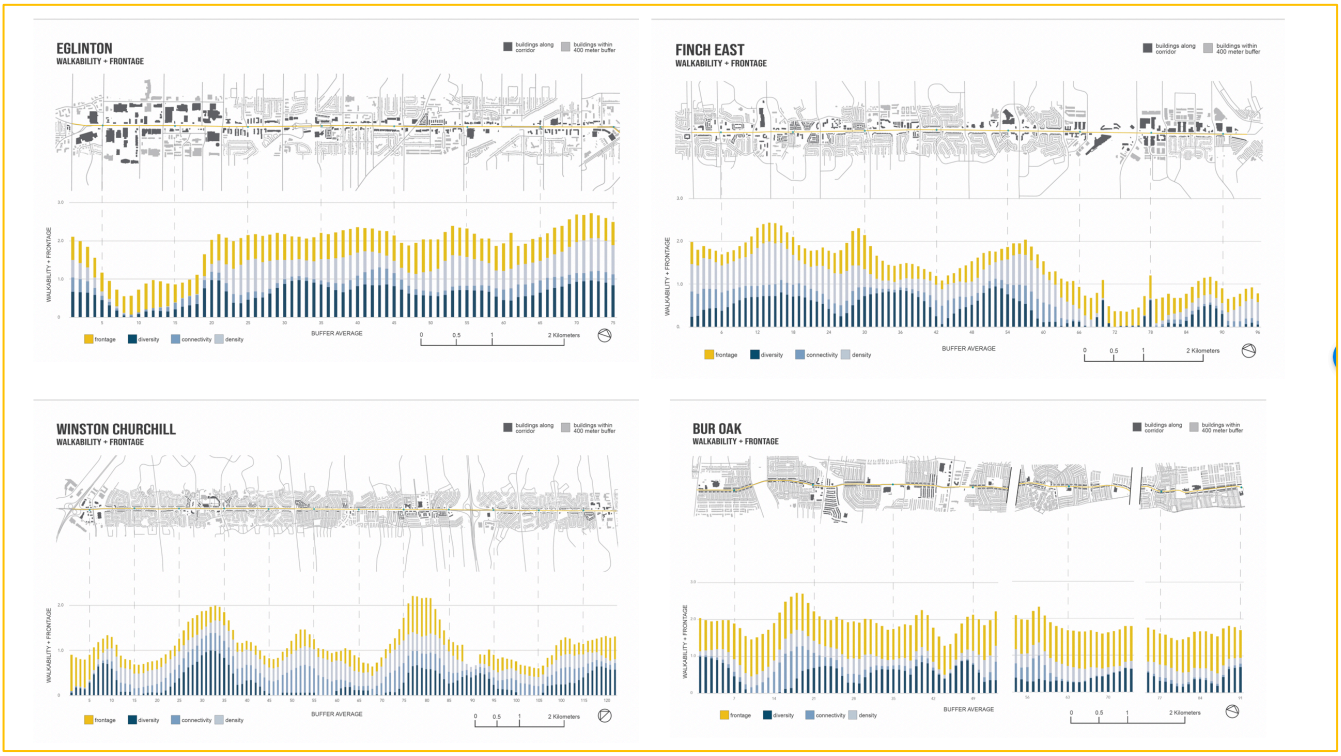

Figure 4. Spatial and Visual Representation of Walkability Scores

Figure 5. presents the analysis of redevelopment potential along the four corridors. Summary findings are as follows:

- Redevelopment potential declines across the four periods examined, with Eglington having the most potential in terms of both total corridor frontage and total area, and Burr Oak having the least.
- The most potential occurs in areas of large lot commercial and employment uses, which are abundant on Eglinton and Finch East. These are also the areas that score the lowest in walkability.
- Overall, Eglinton which scores highest on walkability, also has the most potential for transformation, with some potential also existing in areas that already have relatively high walkability scores.
- Redevelopment potential on Winston Churchill is mostly limited to small shopping centres distributed along the corridors. These are also the areas that currently have the highest walkability. Transformation potential between these centres is limited.
- Although measuring fairly high on walkability overall, the least potential for transformation exists on Burr Oak, occurring as in Winston Churchill at small shopping centres.

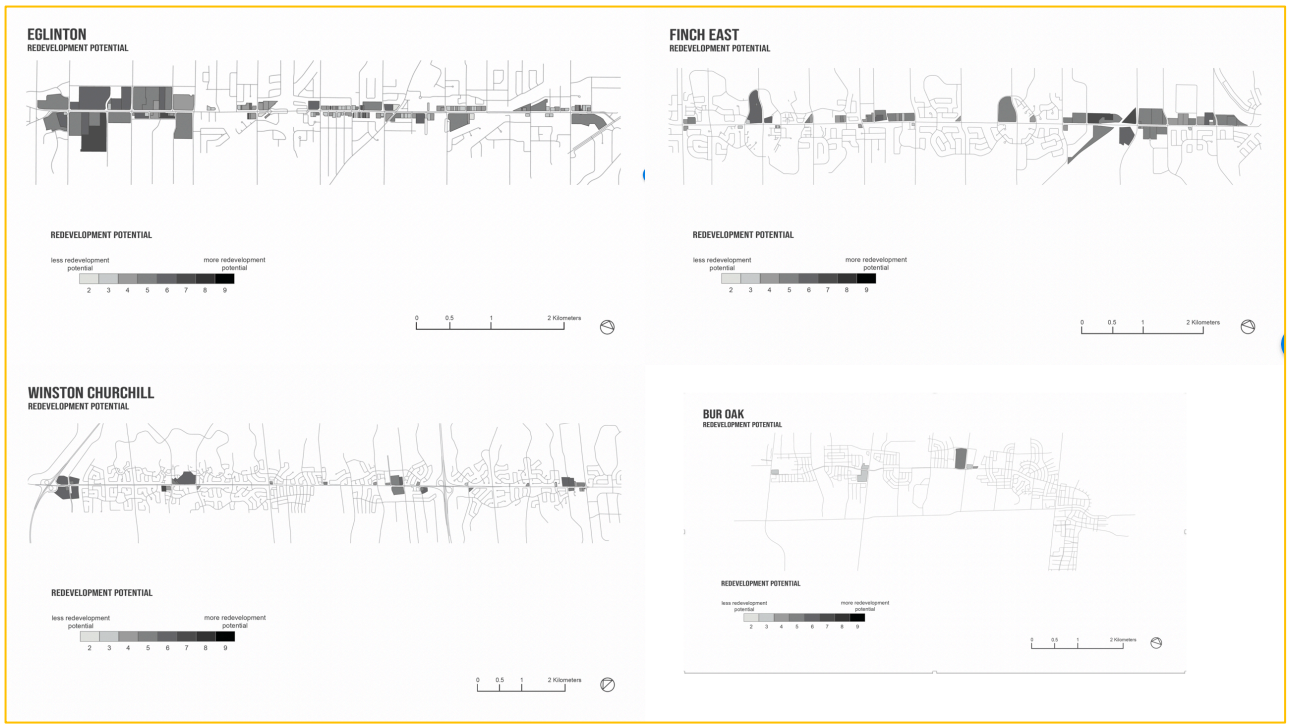

Figure 5. Redevelopment Potential Across Corridors

DISCUSSION AND CONCLUSION

This research demonstrates that the walkability, and by implication, the transit-orientation of suburban corridors can be measured using tools drawn from the land use transportation literature and urban morphology. As Scheer notes, understanding the detailed patterns of suburban development patterns is foundational to retrofitting strategies.

The research adds to this understanding, showing that four Toronto region arterial corridors have distinct patterns of urban form and redevelopment potential. With the exception of Burr Oak, the corridors are composed of fairly standard suburban topologies such as shopping plazas, strip malls, and apartment complexes, but their overall morphologies reflect the planning and development regimes under which they were developed that shaped how these elements are arranged. In general, corridor planning and development in the Toronto region became more controlled, retail uses increasingly clustered into centers with tightly controlled roadway access, and residential development increasingly designed with reverse-lot layouts over time. Thus, both walkability and the potential for transformation declined with stronger planning controls.

This has implications for the potential for retrofitting these corridors into more walkable, transit-oriented places. Indeed, Eglinton, with some vestiges of pre-war lot division and developed under relatively weak planning controls, is most walkable corridor with the largest potential for transformation in the study. Winston Churchill, the last corridor developed before the influence of New Urbanism, is both the least walkable and has poor potential for transformation except at a few, limited locations.

The case of Burr Oak is different, demonstrating the influence of New Urbanist ideas by creating buildings oriented toward the roadway. Interestingly, however, Burr Oak did not measure as the most walkable corridor overall, and it scored most highly around a conventional suburban shopping centre that introduces more than token amounts of retail uses. Densities were only in the medium range, and even street connectivity was lower than expected due to large amounts of open space and very large institutional campuses. Further, the morphology is at least as controlled and difficult to transform as corridors developed under the previous, auto-oriented planning regime.

In conclusion, older, more central, less planned corridors may have the greatest potential for retrofitting corridors into walkable, transit-oriented places. More recent, highly planned and perhaps more ubiquitous corridors have little such potential. The question is new areas of suburban development created in the era of New Urbanism and smart growth. As evidenced by Burr Oak, these corridors can be made to be more walkable and transit oriented at the local scale. However, given that the general auto-orientation at a broader scale does not seem to have decreased, the implications for this type of frozen or inelastic form are not yet clear.

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