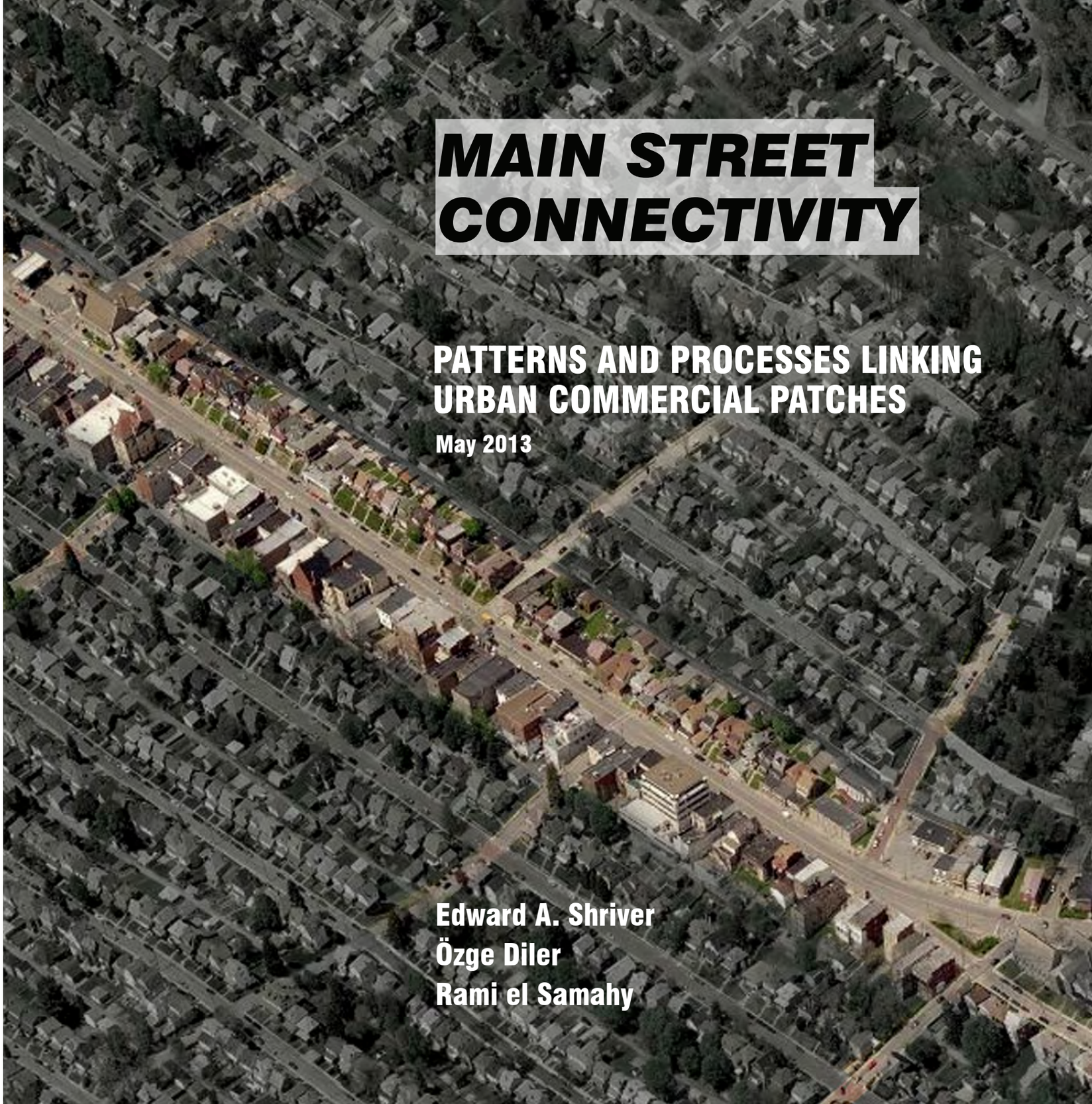

MAIN STREET CONNECTIVITY

PATTERNS AND PROCESSES LINKING URBAN COMMERCIAL PATCHES

May 2013

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Özge Diler
Rami el Samahy

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ACKNOWLEDGEMENTS

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We also want to thank Carnegie Mellon University School of Architecture, its staff, faculty and students for their help, support and contributions to this work. While there are too many to name individually, this work could not have been completed without their contributions.

We would also like to thank Susan Tymoezko, Zoning Administrator City of Pittsburgh Department of City Planning and Robert Rubenstein, Director, Urban Redevelopment Authority of Pittsburgh for their time and input into reviewing our work.

Lastly, I want to thank my partners in this effort, Rami el Samahy and Özge Diler for their support, contributions and long hours in this effort. Both these professionals dedicate considerable time to the education of others, and this effort hopefully serves that interest well.

Edward A. Shriver

chapter 1

INTRODUCTION

ABSTRACT

The urban environ is organic and diverse - ecologically and socially because the lack of a single controlling entity means a much broader range of businesses (national chains, local specialty, neighborhood service, bars, pawn shops, and every other kind of retailer) can evolve. This creates what Christopher Alexander, noted architect and author of "*A City is Not A Tree*", called "a large collection of many small systems (that) goes to make up a large and complex system"[1]. Alexander called it a lattice. It is in fact an ecosystem - a living city.

[1] Christopher A., *A City Is Not A Tree.* London: Design Council, 1966. Print.

GOALS

[2] Grimmett, G., *Percolation*, Springer, 1999

We have applied landscape ecology tools — the assessments and analysis of the patterns and processes to main street — in an effort to get beyond the superficial causes of urban form and architectural response and understand the underlying drivers of this urban ecosystem. Specifically, we look at how main streets connect. Spatial patterns are inherently complex. To understand the patterns, we model the processes that cause them.

One important process is percolation. Water seeping through cracks in rocks is an example. Several common landscape processes, both physical and biotic (biological), are essentially percolation, such as the spread of epidemics, fire, animals moving through a forest, invasion of exotic species, diffusion in the soil, and the spread of new genotypes through a population.

Percolation Theory examines the flow of a fluid through a matrix. The mathematical algorithms underpinning the theory are well defined and studied[2], but its ultimate correlation to actual results depends entirely on a clear understanding of the relevant qualities and characteristics of both the matrix and the fluid rather than the math.

Basing our hypothesis on Percolation Theory as it is used in landscape ecology studies of connectivity, we look for the elements critical to forming connectivity in three separate main street locales, in order to extract elements common to success or failure to connect. In our case, the fluid is people and the matrix is the urban environment. The result is stated as a percentage or probability ($0 < P < 1$) that a connected path will occur that reaches from one end of the matrix to the other. A particularly interesting characteristic of percolation is its threshold effect or tipping point, where at the critical point, Pc, the path suddenly connects (see Figure 1,2 and 3). The existence of this critical threshold means that below Pc exist numerous separate fragmented clusters, while above the critical Pc one large dominant cluster forms. It is important to recognize that this threshold affect is time dependant, i.e. the changes occur over time, resulting at some point in a relatively sudden change over the entire matrix.

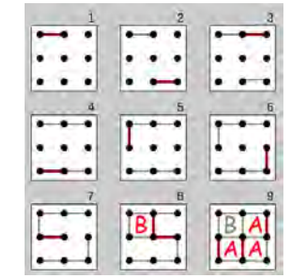
Because percolation depends in part on the physical structure of the matrix, a hypothetical Pc can be determined based on simple spatial adjacencies called 'neighborhood' rules. The Pc's of various neighborhood configurations is logarithmic (see Figure 11).

The goals of our study are:

1. Validate the use of Percolation model as a viable tool for assessment of main street connectivity and assess neighborhood configurations.

2. Identify critical factors that affect main street connectivity so that design intervention can improve connectivity or mitigate impediments to connectivity.

3. Begin to define the relative importance and relationship between those factors, for future input into computer modeling efforts using a Percolation based model.



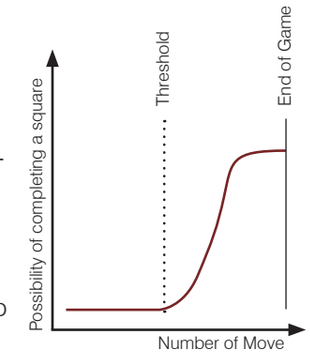


Figure 1&2: Lines and Dots game diagram[3] and a graph show the possibility of completing a square as moves are made by each player. As the lines are placed, the possibility of completing a square increases until a threshold is reached. At that point all the dots connects and the game ends. Main street connectivity works the same way. Each additional retail units on a retail corridor increase the possibility of connectivity.

[3] http://commons.wikimedia.org/wiki/File:Dots-and-boxes.svg?uselang=fa

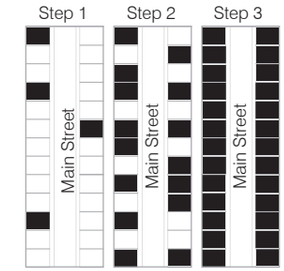


Figure 3: The possibility of stores coming together on a retail corridor increases over time. Stores are represented as black boxes.

chapter 2

METHODOLOGY

2.1 APPROACH

[4] See Chapter 6.0 Reference for Urban Lab syllabus

Our approach was to deal with three separate main street locations as case studies, to identify patterns in the organization and current use of the locations. Our first step was to collect base map and site information by students in Carnegie Mellon University's Fall 2012 Urban Lab studio[4] under the direction of Rami el Samahy and the CMU School of Architecture faculty. This work would provide data for our analysis while also providing students with background information for their design initiatives. Throughout the semester this interaction between the research efforts and the design studio were important for providing both the research team and the class with a variety of insights and 'fresh eyes' on the subject at hand. It also provided the students with first hand experience in practical research in architecture, as Ed Shriver presented his earlier studies, hypothesis and understandings at an early session of the entire class. The students design work in turn tested some of the findings and explored how this understanding might inform future design efforts in the study area. Finally, a survey of students and instructors provided base-line data to compare analytical results to an intuitive measure derived from people knowledgeable about both the local communities and architecture and urban design.

The venue of the study changed from the original research proposal in that the original study area, Pittsburgh's East End, was changed to the South Hills area. The East End has been extensively studied by the School of Architecture (and Strada), and the South Hills provided the opportunity to look at new sites (Figure 4). As a result, we can now compare our data collected for this study with previously collected data from East End sites, providing a larger data set of comparative information to compare and contrast the separate areas, making the analysis more robust.

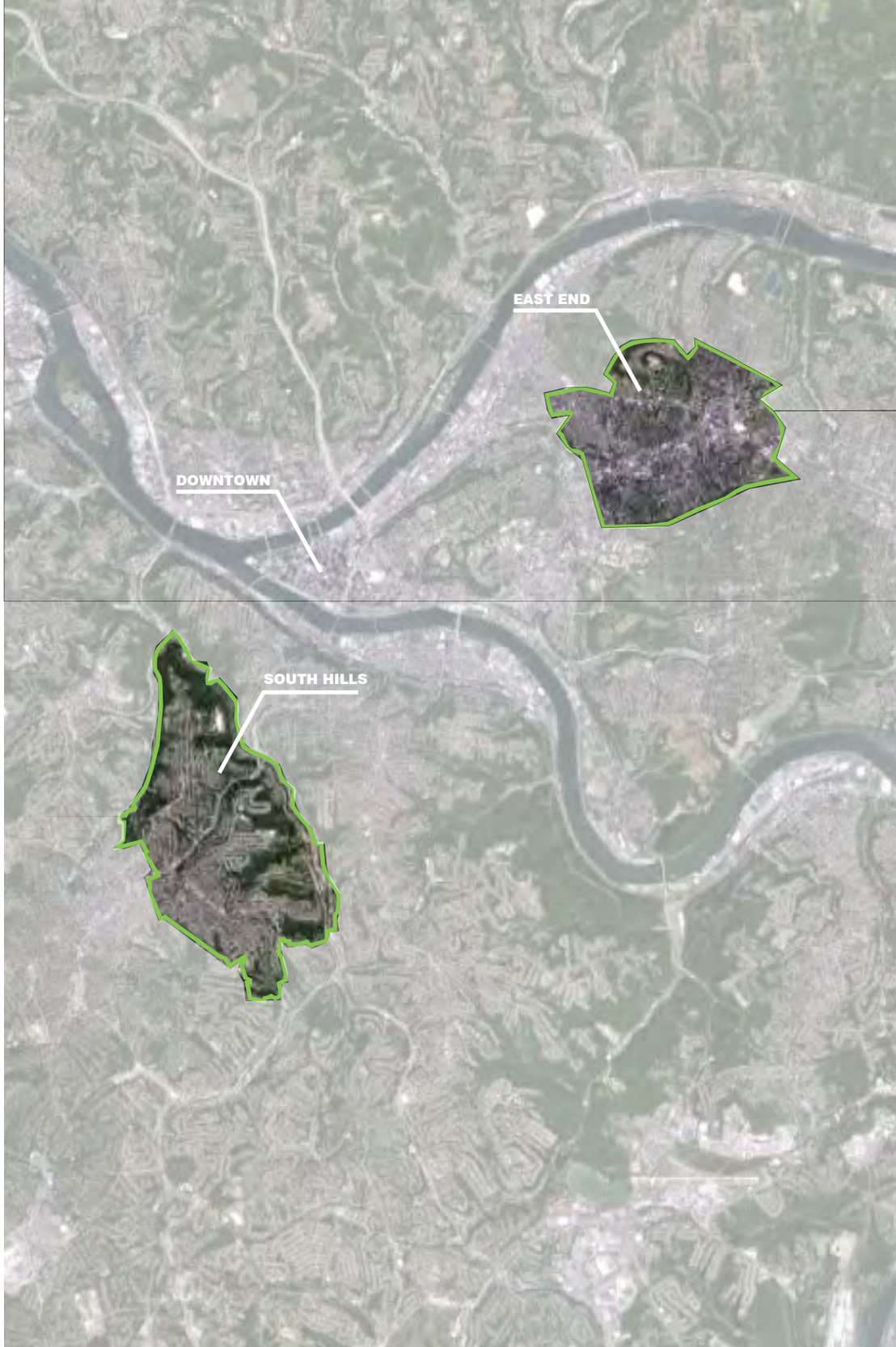


Figure 4 (page 17): Location of South Hills, East End and Downtown Pittsburgh

2.2 FOCUS AREAS

The three sites selected were in the neighborhoods of Beechview and Brookline. The sites selected include the retail corridors of *Broadway Ave* (Beechview), a weak commercial corridor along a trolley line that runs into downtown Pittsburgh; *Brookline Blvd* (Brookline), a vibrant and ethnically diverse main street; and *W. Liberty Ave* in-between the two, a classic 1950s suburban commercial corridor of car dealerships and fast food restaurants (see Figure 5).

Figure 5: Three main streets in South Hills.

2.3 DATA COLLECTION

Community group meetings and presentations of studio work and design concepts were organized, and feedback and anecdotal local insights were recorded for both original insights and for verification of conclusions.

2.4 LITERATURE SEARCH

In addition to the studio' work in collecting data and surveying the study sites, a literature search was conducted to identify the context within which this effort would reside. A bibliography of that work is appended to this report. Of particular relevance to this study from an architectural perspective were works on *Natural movement: or, configuration and attraction in urban pedestrian movement*[5] which makes an argument for a strictly geometric analysis of movement in an urban environment, and M. Batty's work *Cities and Complexity*[6] which assesses urban form through cellular automata and agent based modeling.

Hillier proposes that a strictly geometric analysis of the urban form called Spatial Syntax generates a highly correlated relationship between movement patterns and space syntax 'integration' measure. Another study, *Urban texture and space syntax: some inconsistencies*[7] by Ratti addresses some mathematical problems associated with this approach, but the underlying conception that geometry drives movement regardless of human interaction is distinctly different and therefore an interesting foil for our analysis.

Batty's work is more closely related to our effort. Batty's analysis of urban structure and movement is actually a variation on percolation theory, in that he proposes sophisticated computer modeling based on very similar concepts to our hypothesis. Batty's proposal to endow cells (places/matrix) and agents (people/fluids) with simple rules about interaction is fundamentally an ecological, even biological approach. Batty's approach differs from ours in that he focuses on modeling patterns to reflect urban forms.

[5] Hillier B., Penn A., Hanson J., Grajewski T., Xu J., *Natural movement: or, configuration and attraction in urban pedestrian movement.* London: WC1H 0QB, 1989, revised form in 1992.

[6] Batty M., *Cities and Complexity: Understanding Cities with Cellular Automata, Agent-Based Models, and Fractals.* Cambridge, Mass.: MIT Press, 2005.

[7] Ratti C., "Space syntax: some inconsistencies." In *Environment and Planning B: Planning and Design,* 2004. Volume 31(4) 487 – 499.

Our approach is to model characteristics to test their applicability to understanding the causes of urban form. Batty's rule based analysis may provide a way forward in future analysis of urban ecosystems using characteristics (rules) developed in studies such as ours.

On the landscape ecology side, works such as *Landscape Ecology in Theory and Practice*[8] and *Complexity in Landscape Ecology*[9] provided inspiration and guidance on the landscape ecology approaches.

[8] Turner M., Gardner R., O'Neill R., *Landscape Ecology in Theory and Practice - Pattern and Process.* New York: Springer-Verlag, 2001, p. 143.

[9] Green D., *Complexity in Landscape Ecology*. Dordrecht, The Netherlands: Springer, 2006

chapter 3

PERCOLATION THEORY

3.1 VALIDATING PERCOLATION - CONSTRUCTING AN URBAN PERCOLATION MODEL

We began by looking at what size module should form the basis of our analysis, to determine the appropriate scale of peoples' interaction with their space. "Neutral or null models in ecology provide a useful baseline for comparison when examining potential cause and effect relationships. In terms of landscape ecology, a neutral model is one that exhibits characteristic spatial patterns in the absence of processes that may affect patterns in real landscapes…" *Learning Landscape Ecology*[10]

Studies show that humans derive approximately 70% of their information about the world around them through their eyes. We therefore focused primarily on visual factors in identifying the characteristics for determining patch/module size. William Whyte, the noted sociologist and student of the human use of urban spaces, noted that when people walk in the city, they generally look about 100' in front of them, and can recognize a friends face at about 70'[11].

Using these numbers and using standard information on eyesight and cones of vision as a starting point, we constructed several models of how people might perceive space. We initially defined modules of 24' (~1/3 of 70' (the detailed vision range)), 36' (~½ of 70'), and 70' as our basic units, and began testing these modules. We used data collected from both the South Hills sites and legacy data from earlier East End and Downtown sites to develop neutral model (NM) percolation coefficients in which the actual patch counts was site specific, but the physical configuration was generic (see Figure 6 below).

[10] Gergel S., Turner M., *Learning Landscape Ecology - A Practical Guide to Concepts and Techniques.* The Netherlands: Springer, 2002.

[11] In studies conducted by Strada for previous work, it was determined that when people walk in the city they generally look about 100' in front of them, and can recognize details and faces at about 70'.

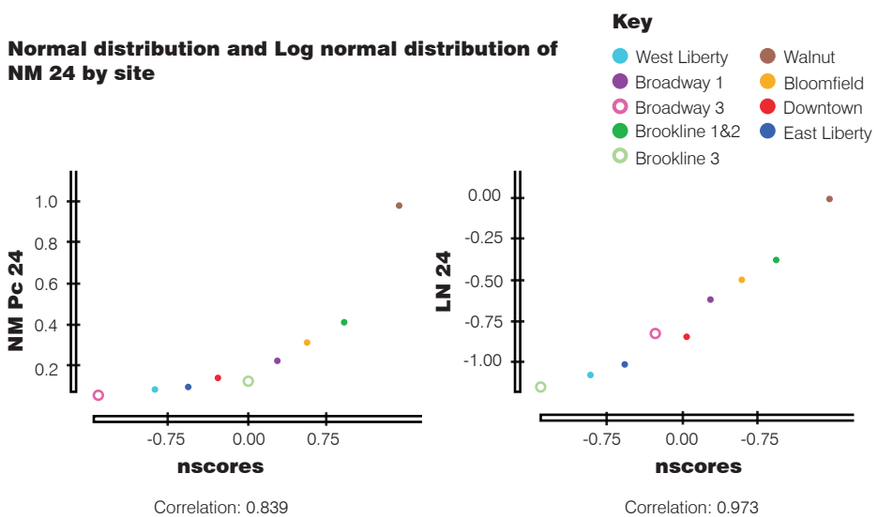
Neutral Model Pc based on 24' modules (sorted by Theoretical Pc)

Figure 6: Calculations based on 24' modules

Column	A	B	D	F	G
Formula				(D/24)*2	B/F
	Total patch (count)	Total active retail patch	Street length (ft)	Units possible @24' unit	Neutral Model Pc active/possible (24') NM 24
Walnut	95	93	1120	93.3	0.9964
Brookline 1&2*	151	84	2400	200.0	0.4200
Bloomfield	121	110	4225	352.1	0.3124
Broadway 1*	45	24	1200	100	0.2400
Downtown	394	258	21960	1830.0	0.1410
Broadway 3*	21	6	600	50	0.1200
East Liberty	172	88	10724	893.7	0.0985
West Liberty	123	53	8300	691.7	0.0766
Brookline 3*	23	5	890	74.2	0.0674
Average					0.2012
Median					0.1410

* Broadway Avenue and Brookline Boulevard are divided into different segments because their retail make up is significantly different. Please see Chapter 4.2 and 4.3 to see details about these retail corridors.

Normal distribution and Log normal distribution of NM 24 by site



Correlation: 0.839

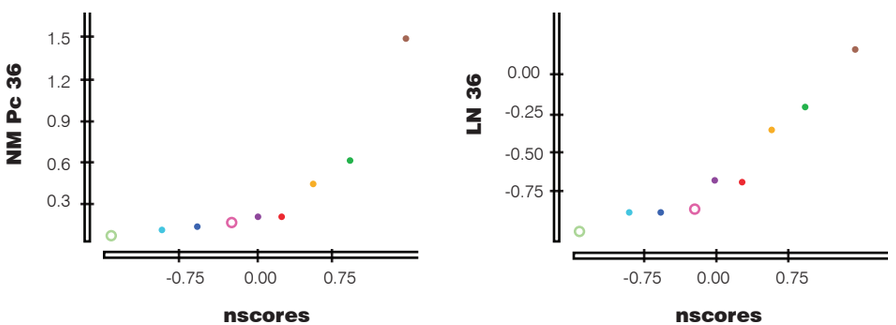
Correlation: 0.973

Figure 7: Calculations based on 36' modules

Neutral Model Pc based on 36' modules (sorted by Theoretical Pc)

Column	A	B	D	L	M
Formula				(D/36)*2	E/L
	Total patch (count)	Total active retail patch	Street length (ft)	Units possible @36' unit	Neutral Model Pc active/possible (36') NM 36
Walnut	95	93	1120	62.2	**1.4946**
Brookline 1&2	151	84	2400	133.3	0.6300
Bloomfield	121	110	4225	234.7	0.4686
Broadway 1	45	24	1200	133.3	0.1800
Downtown	394	258	21960	1220.0	0.2115
Broadway 3	21	6	600	33.3	0.1800
East Liberty	172	88	10724	595.8	0.1477
West Liberty	123	53	8300	461.1	0.1149
Brookline 3	23	5	890	49.4	0.1011
Average					0.3921
Median					0.1800

Normal distribution and Log normal distribution of NM 36 by site



Correlation: 0.813

Correlation: 0.940

Key

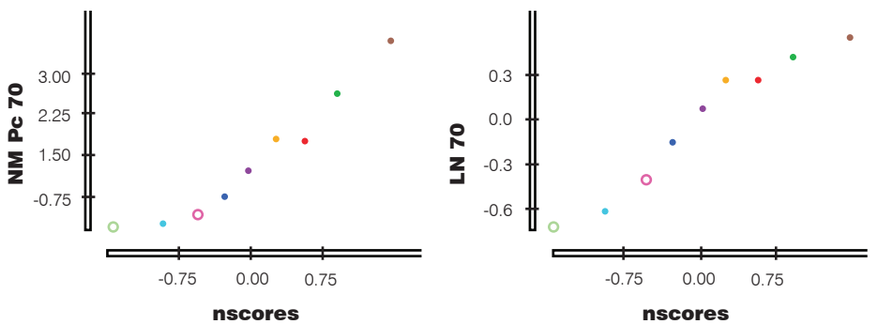
- West Liberty
- Broadway 1
- Broadway 3
- Brookline 1&2
- Brookline 3
- Walnut
- Bloomfield
- Downtown
- East Liberty

Neutral Model Pc based on 70' modules (sorted by Theoretical Pc)

Figure 8: Calculations based on 70' modules

Column	A	B	D	L	M
Formula				(D/70)*2	E/Q
	Total patch (count)	Total active retail patch	Street length (ft)	Units possible @70' unit	Neutral Model Pc active/possible (70') NM 70
Walnut	95	93	1120	16.0	**5.8125**
Brookline 1&2	151	84	2400	68.6	**1.2250**
Bloomfield	121	110	4225	60.4	**1.8225**
Broadway 1	45	24	1200	34.3	0.7000
Downtown	394	258	21960	313.7	0.8224
Broadway 3	21	6	600	17.1	0.3500
East Liberty	172	88	10724	153.2	0.5744
West Liberty	123	53	8300	237.1	0.2235
Brookline 3	23	5	890	25.4	0.1966
Average					0.8168
Median					0.7000

Normal distribution and Log normal distribution of NM 70 by site



Correlation: 0.961

Correlation: 0.976

Key

- West Liberty
- Broadway 1
- Broadway 3
- Brookline 1&2
- Brookline 3
- Walnut
- Bloomfield
- Downtown
- East Liberty

[12] See Chapter 6.3 Survey Results for detailed information about survey results

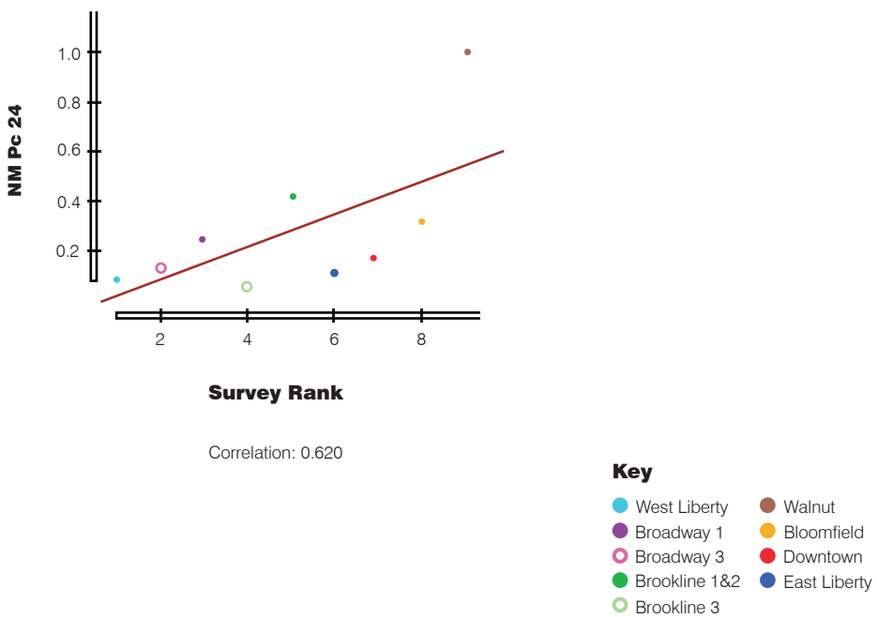
In testing these patch sizes, the 36' module generated Pc's that in some cases exceeded 1 (Figure 7 table, shown with dark purple), and 70' generated more Pc > 1, so these sizes were too large for the scale of our analysis. The 24' dimension was chosen because it generated Pc's consistently within the limits (0 < Pc < 1) without constraint (i.e. the distribution of results span the entire spectrum from 0-1, even for streets that seem highly connected (Walnut Street) and disconnected (Brookline 3). It is also notable that the 24' dimension matches up well with the physical layout of the urban spaces surveyed, as 24' (+/-) seems to be a common lot size in early American surveys as well as a standard structural span for spaces. All further analysis was based on the 24' module. These theoretical Pc's were used as a benchmark to compare our actual site calculations against.

We then looked at the neutral model Pc calculations and compared them to the survey results[12] from the class participants and legacy data. Ranking numbers are 9 = strong connectivity, 1 = weak/no connectivity.

Neutral Model Pc based on 24' modules correlated to Survey data

Figure 9: Data and correlation graph based on Neutral Model.

Column	A	B	D	F	G	H
Formula				(D/24)*2	B/F	
	Total patch (count)	Total active retail patch	Street length (ft)	Units possible @24' unit	Neutral Model Pc active/possible (24') NM 24	Survey Rank
Walnut	95	93	1120	93.3	0.9964	9
Brookline 1&2	151	84	2400	200.0	0.4200	5
Bloomfield	121	110	4225	352.1	0.3124	8
Broadway 1	45	24	1200	100	0.2400	3
Downtown	394	258	21960	1830.0	0.1410	7
Broadway 3	21	6	600	50	0.1200	2
East Liberty	172	88	10724	893.7	0.0985	6
West Liberty	123	53	8300	691.7	0.0766	1
Brookline 3	23	5	890	74.2	0.0674	4
Average					0.2012	
Median					0.1410	



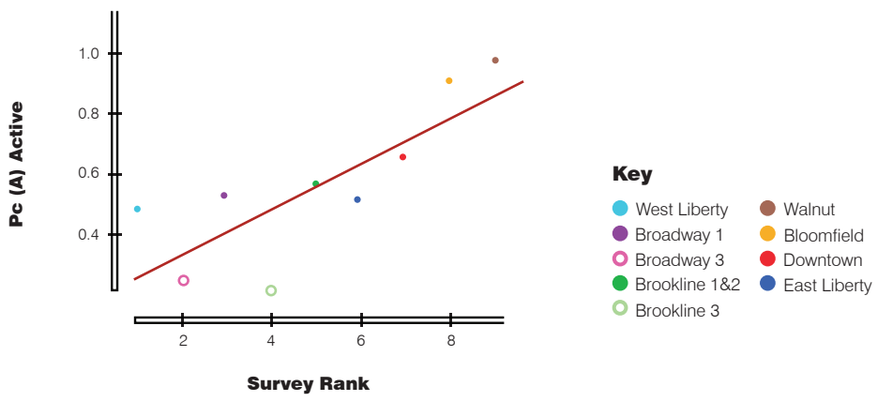
The neutral model Pc calculation has a moderate correlation to the survey data, suggesting that the hypothesis has some validity at a conceptual level, but the divergence particularly in the mid-range suggests that the Neutral Model Pc will not be a useful predictor of connectivity on its own. It should be remembered that the purpose of the Neutral Model is to serve as a baseline relative to spatial characteristics.

We then calculated actual Pc's for all sites using retail occupancy as our starting point (total active patches/ total patches Pc (A)). The rationale for this initial choice is the assumption that, because these are commercial corridors, active retail (i.e. any functioning commercial activity open to the public) was what people would perceive as connectivity.

Pc (A) based on 24' modules correlated to Survey data (sorted on Pc (A))

Figure 10: Data and correlation graph based on Pc (A)

Column	A	B	D	F	G	H	I
Formula				(D/24)*2	B/F		B/A
	Total patch (count)	Total active retail patch	Street length (ft)	Units possible @24' unit	Neutral Model Pc active/possible (24') NM 24	Survey Rank	Pc (A) – active/ total
Walnut	95	93	1120	93.3	0.9964	9	0.9789
Bloomfield	121	110	4225	352.1	0.3124	8	0.9091
Downtown	394	258	21960	1830.0	0.1410	7	0.6548
Brookline 1&2	151	84	2400	200.0	0.4200	5	0.5563
Broadway 1	45	24	1200	100	0.2400	3	0.5333
East Liberty	172	88	10724	893.7	0.0985	6	0.5116
West Liberty	123	53	8300	691.7	0.0766	1	0.4309
Broadway 3	21	6	600	50	0.1200	2	0.2857
Brookline 3	23	5	890	74.2	0.0674	4	0.2174
Average					0.2012		0.5545
Median					0.1410		0.5333



Correlation: 0.825

The Pc (A) correlates more strongly to the survey data than the neutral model Pc, as it should. The Pc calculation predicts the survey results with a reasonably high level of fidelity.

3.2 Neighborhoods

Our next step was to determine an appropriate neighborhood configuration. Neighborhoods in a landscape ecology context are aggregate configurations of patches (modules) that reflect the biological drivers of a process. “The ecological justification for the analysis of landscape patterns with different neighborhood rules is process driven. For instance, if dispersal of a disturbance is slow and by immediate contact, the nearest neighbor rule (4 square) might be applied… However, short distance dispersal of large seeds might cover a neighborhood of considerable area, resulting in a revised definition of connectance among neighboring sites.” [13]

The most common neighborhood rules are Moore’s Neighborhood, a 9 square grid (3x3) who’s Pc is ~ .39, and Von Neumann’s Neighborhood, a 5 square (central space plus N,S,E, and W adjacencies) who’s Pc is ~.50. We also studied a 3 square linear configuration, who’s Pc is ~.63. “The size of the neighborhood reflects the range at which the causes of the pattern are effective. Larger neighborhoods imply causes at greater range. If the value of Pc is estimated from a specific neighborhood rule (e.g. the neighborhood defined according to species or disturbance specific parameters) then the ecological dynamics can be expected to shift at the critical threshold.”[14] The configuration of the neighborhood reflects and defines the resulting pattern.[15]

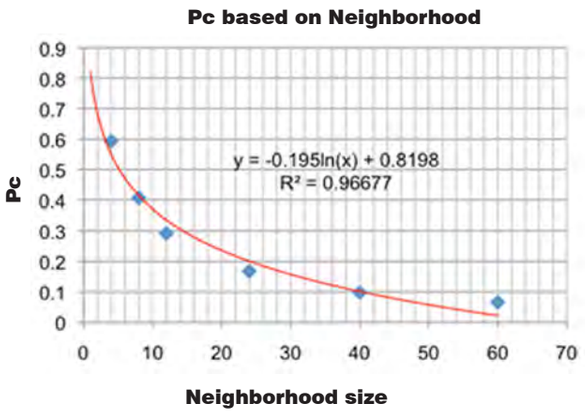


Figure 11: Chart shows Pc based on different neighborhood configurations

[13] Turner M., Gardner R., O’Neill R., *Landscape Ecology in Theory and Practice - Pattern and Process.* New York: Springer-Verlag 2001. p 146.

[14] Turner M., Gardner R., O’Neill R., *Landscape Ecology in Theory and Practice - Pattern and Process.* New York: Springer-Verlag, 2001, p. 146-7.

[15] Batty M., *Cities and Complexity: Understanding Cities with Cellular Automata, Agent-Based Models, and Fractals.* Cambridge, Mass.: MIT Press, 2005.

We identified three neighborhood configurations that seemed to represent different human spatial interactions, for assessment.

A three-neighbor configuration, Pc ~.63

representing a strongly linear perception of space such as one side of a street, where the other side had no bearing on the connectivity of the side in question.

A five-neighbor (Von Neumann) configuration, Pc ~.50

representing a connective relationship only immediately around the point of study, but non-linear.

A nine-neighborhood (Moore’s) configuration, PC ~.39

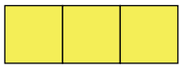
representing the broadest connective inter-relationship of the three.

We evaluated theoretical and actual Pc’s based on three different neighborhood configurations. Recall that Pc defines the threshold or tipping point at which a matrix ‘connects’. Knowing where this threshold is makes the application of Percolation Theory relevant and useful in architectural and urban design terms.

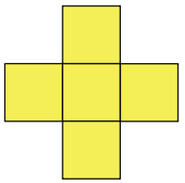
Neighborhoods beyond a 9-neighbor arrangement mean that people are affected by some factor that is at least 36’ away from the viewer. It also reduces the estimated Pc to less than a 39% threshold, above which any site should connect.

Figure 12: Neighborhood configurations

3-neighborhood



5-neighborhood



9-neighborhood

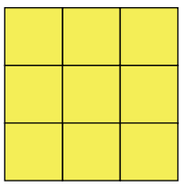


Figure 13: Diagram shows 5-neighborhood rule applied to main street

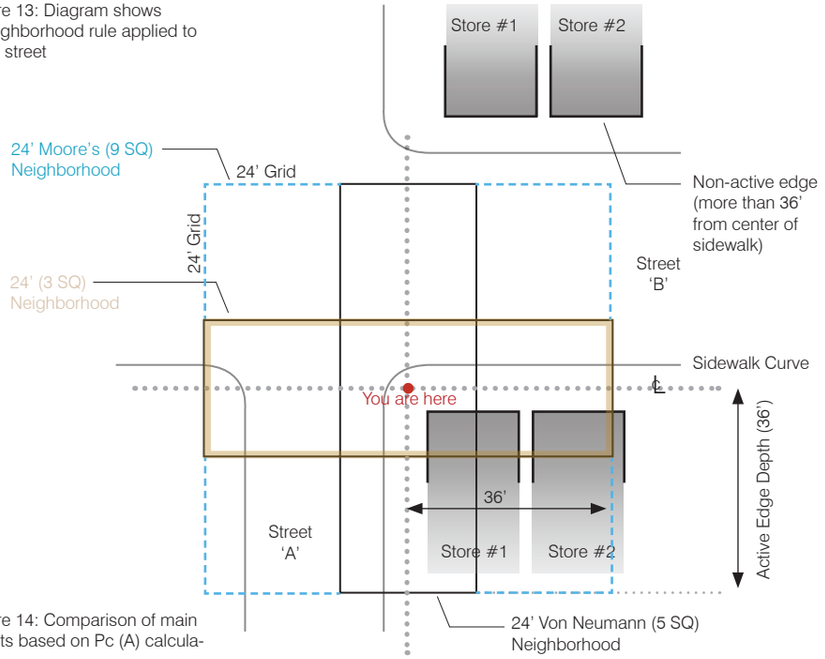


Figure 14: Comparison of main streets based on Pc (A) calculations

*Y – Percolates
*TP – On the threshold of connectivity

Pc (A) based on 24' modules assessed with various neighborhood Pc

Column	A	B	D	F	G	H	I			
Formula				(D/24)*2	B/F		B/A			
	Total patch	Total active retail patch	Street length (ft)	Units possible @24' unit	Neutral Model Pc active/possible (24') NM 24	Survey Rank	Pc (A)–active/total	Pc > .39	Pc > .50	Pc > .63
Walnut	95	93	1120	93.3	0.9964	9	0.9789	Y*	Y	Y
Bloomfield	121	110	4225	352.1	0.3124	8	0.9091	Y	Y	Y
Downtown	394	258	21960	1830.0	0.1410	7	0.6548	Y	Y	Y
Brookline 1&2	151	84	2400	200.0	0.4200	5	0.5563	Y	Y	TP
Broadway 1	45	24	1200	100	0.2400	3	0.5333	Y	Y	
East Liberty	172	88	10724	893.7	0.0985	6	0.5116	Y	Y	
West Liberty	123	53	8300	691.7	0.0766	1	0.4309	Y	TP	
Broadway 3	21	6	600	50	0.1200	2	0.2857	TP*		
Brookline 3	23	5	890	74.2	0.0674	4	0.2174			
Average					0.2012		0.5545			
Median					0.1410		0.5333			

We believe that a 3-neighbor rule most accurately reflects the data to date, but the 5-neighbor should not be ruled out. - The 3N rule is consistent with the survey results in terms of connectivity ranking. The 5N rule is slightly less predictive in the mid-range but generates more connected main streets which seems consistent with survey, but warrants more data. Because the neighborhood rule reflects the processes that underlay the patterns we see, this question is one that requires more study.

At this point, it seems reasonable to say that Percolation Theory does have validity as a tool to measure and predict peoples' response to the 'connectedness' of a main street. That by itself is not particularly useful. What we really want to know is: what are the elements of placemaking that are perceived as connectivity? And more to the point: how do we create successful main streets?

3.3 CRITICAL DRIVERS AFFECTING MAIN STREET CONNECTIVITY

Once a module had been established and an appropriate neighborhood rule chosen, we began to assess the characteristics that might affect the connectivity of a main street. We proposed an initial Pc based on the ratio of active retail as a percentage of all patches on the assumption that retail streets with more retail would connect better than streets with limited retail. This ratio is used as our starting point in developing a Percolation Coefficient (Pc) that reflects both the matrix qualities of the Neutral Model and the perceptual characteristics captured in the Survey Rank. We then test them to see which characteristics correlated strongly with our initial test Pc (A), the Neutral Model Pc 24 and the Survey Rank benchmarks. Along the way we identified other potential Pc variations that we also tested to assess their strengths and weaknesses as predictors.

Characteristics that seemed important as drivers affecting connectivity were identified early in the studio;

1. storefronts seem to be important in supporting a sense of connectedness,
2. the integrity of the street wall – some measure of how much storefront or building face existed as a percentage of the whole length of the street, and
3. density, i.e. how much (quantity) and how varied (diversity/uniformity and dominance) was the retail on the main street.

Characteristics specific to the main streets we considered in our analysis that, represent different characteristics that define the matrix included:

- Number (patch count), active retail count, and vacancy count.
- Storefront length (active/vacant and solid/void).
- Composition of patch types (function) by NAICS code.
- Composition of patch types.
- Density of commercial uses.
- Variety (different unit types)
- Largest single patch type (NAICS code) and the dominance (as a percentage of all patches of that type within the study area) of that patch type.
- Spatial voids as a percentage of total street length.
- Arrangement and distribution of commercial, non-commercial and vacant uses within each study area.

We also identified several characteristics and metrics that capture important qualities of the broader communities:

- Population of the community.
- Median household income.
- Percentage of home ownership.
- The walkability of the community as measured by Walk Score.[16]

An interesting question arose regarding transit and it impact on main street. Broadway has a functional and seemingly well-used trolley line that runs the length of the community and connects it directly to downtown. The community was originally conceived and promoted based on that connection to downtown, yet this commercial patch had very low perceptual rankings of connectivity even early in the semester work.

These variables represent different characteristics that define the matrix. See Figure 15.

[16] www.walkscore.com

DATA SET	Downtown	Walnut St.	Bloomfield	E. Liberty	W. Liberty	Brookline 1&2	Brookline 3	Broadway 1&2	Broadway 3
Total Patches	394	95	121	172	123	151	23	45	21
Active Retail Patches	258	93	110	88	53	84	5	24	6
Vacant Patches	78	2	11	84	38	12	3	15	4
Different Types	77	31	49	50	27	49	3	19	2
Dominance	0.16	0.13	0.20	0.09	0.17	0.14	0.40	0.13	0.33
Density (units/acre)	4.67	8.33	2.78	1.92	2.15	7.31	5.75	7.47	10.5
Voids % Pc (V)		0.58	0.41		0.26	0.48		0.42	0.34
Retail Storefronts Pc (E)		0.756	0.367	0.23	0.185	0.573	0.247	0.226	0.303
Fragmentation Pc (O)	0.802	0.979	0.909	0.512	0.691	0.921	0.870	0.667	0.810
Diversity	0.298	0.333	0.445	0.568	0.509	0.583	0.600	0.792	0.3333
Walkability	93	79	88	78	71	57		56	
Population	2721	12910	9375	15524		8295	8295	4646	4646
Owner Occupancy %	0.233	0.21	0.291	0.203		0.636	0.636	0.555	
Median Household Income	69091	40208	32247	31913		52749	52749	45263	45263
Survey Rank *	7	9	8	6	1	5	4	3	2
Retail % Pc (A)	0.6548	0.9789	0.9091	0.5116	0.4309	0.5563	0.2174	0.5333	0.2857
Composite Pc 1	0.6548	0.6120	0.6020	0.2472	0.2053	0.3764	0.1548	0.2531	0.1962

* Survey Rank is higher number = better connectivity

Figure 15: Data set summary

Patch Count on active retail Pc(A), Fragmentation Pc (O)

Patch count is based on a straightforward count of all the patches (buildings/tenant spaces/lots) along both sides of the street.

Each patch's function is defined by identifying its primary NAICS code. NAICS is the North American Industry Classification System used by both the U.S and Canadian governments to classify all business functions. Patches that are identified as functional retail are classified as active retail patches. We counted vacant patches and non-retail patches separately.

To calculate the Pc(A), we divide the number of active retail patches by the total patch count. Active retail excludes non-retail occupied spaces such as churches, police stations, office and residential lobbies and vacant spaces, distilling the analysis to only retail functions.

In calculating Fragmentation - Pc(O), we divide the number of vacant patches by the total patch count, and subtracting that from 1 in order to get a rank order similar to the other calculations, i.e. so all rank orders go from high to low consistently. Pc(O) represents the fragmentation or vacancy for the street.

Patch count measure several issues of quantity relative to connectivity, i.e. does it matter if a main street is short or long, does the amount of retail as a percentage of total patches matter, is a high vacancy rate on a street a factor in perceiving connectivity? Is retail itself a driver (Pc(A)), or is a broader measure of occupancy/fragmentation along the street (Pc(O)) more important?

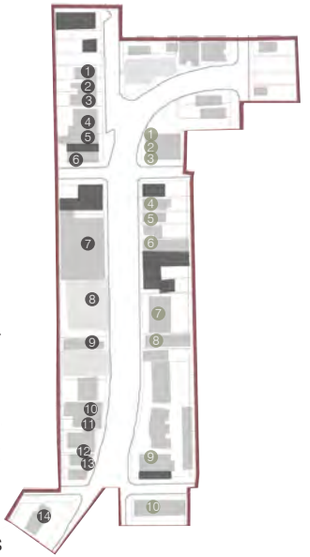


Figure 16: Broadway Avenue 1, is given as an example in order to show a part of patch calculation process.

Density

Density is calculated by dividing the active retail patch count by the study area in acres, including the streets and taken to the rear of the retail patches (usually the back service alley or rear service area.)

Density is another measure of the unit count, but looks at the patches in the context of their local. Do wide streets help or hinder connectivity? This metric will also be helpful in cross-checking the neighborhood rule chosen for Pc since is narrower street width would engage the active edge depth on both sides of the street (see Figure 13). It captures large as well as small retail and basement or second floor retail activity better than a simple count, particularly in locations such as Walnut Street.

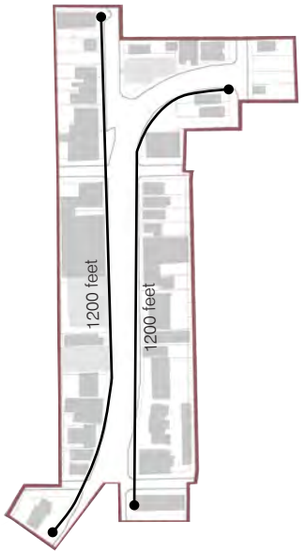


Figure 17: Total length of Broadway Avenue 1

Edge Calculation - Pc (E)

Edge calculations explore the impact of the storefront/street face as a factor in connectivity. This should reflect the impact of large verses small retail functions on connectivity and is a large retailer better than several smaller retailers? What happens when a larger retailer goes 'dark'? (This calculation along with voids, in particularly sensitive to the neighborhood rule)

Total street edge is calculated for both sides of main street. Broadway Avenue is shown in Figure 17 in order to show the steps of calculation. The total dimension for Broadway Avenue is (1200x2) 2400 feet. Street intersections are included to the total length of the streets since they take space from the total length of the street and are a non-active edge.

After having tabulated the total street lengths, the retail store edges are calculated individually. For example, in Figure 18, the colored buildings show all occupied (non-vacant) stores on Broadway Avenue. A 36 foot zone is used to identify 'active storefronts' based on a Von Neumann (5 SQ) rule. An active storefront is defined as an active retail storefront that is within the 36 feet zone. Any retail stores set back beyond 36 feet from the center of the sidewalk was excluded from the calculations, as were vacant and non-retail storefronts. For example, the overall result for the calculation of the north portion of Broadway Avenue is 542 feet out of 2400 feet (the latter being the total length of both sides of Broadway Avenue).

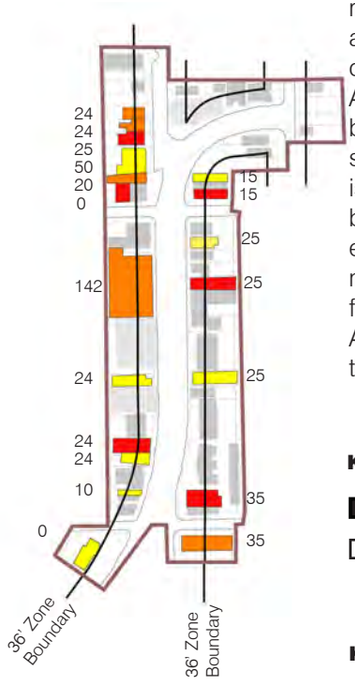


Figure 18: Active storefront edge on Broadway Avenue

Key

- Active storefront edge
- Total length of the street

22.5% of the total street edge is active storefront edge on Broadway Avenue

Key (Figure X and Y)

- All colours represent different retail types
- Buildings
- Local neighborhood commercial district
- 36' zone boundary (offset from the center of the sidewalk)

Transparency, an issue we were unable to explore in depth in this study, is a variation on the Pc (E) where the percentage of the storefront to a height of 36' is transparent. The 36' active edge depth dimension is a function of the 24' module (see Figure 19) applied to the 3rd dimension.

Patch Voids

Patch void measure the impact voids have on connectivity along a main street. This assumption posits that the physical edge condition is the most important driver in determining the pedestrian flow along a street. Does a well defined corridor edge do better job of maintaining a concentration of people on the corridor and encourages movement from one point to the next?

The calculation began with a 24 foot grid of a 5 SQ neighborhood underlaid on the street site plan drawing (the 24' dimension is derived from the modules introduced in the Methodology Chapter). The 24' grid is positioned along the center line of the sidewalk, in an effort to determine the where the 36' zone ends in each study area.

After laying the 36-foot zone lines offset from the center of the sidewalk, Google Earth Pro area calculation tool is used to make estimations. Figure 20 shows a step of calculations on Broadway Avenue in Beechview. As can be seen, the calculated black area includes vacant lots as well as the street. This estimation is recorded. However in order to compare the data with other street calculations, the street area is excluded later on (see Figure 21); because each main street has a different width that would distort void space calculations (for example, Brookline Boulevard is 65 feet wide whereas Walnut Street is 30 feet wide).

Excluding the street area gives us a comparable set of numbers showing actual void to solid ratios within the 36 feet active zone. This 36 foot wide zone can be considered as the potential area where each building can contribute to the physical edge in one of two ways: either by setting back and creating an

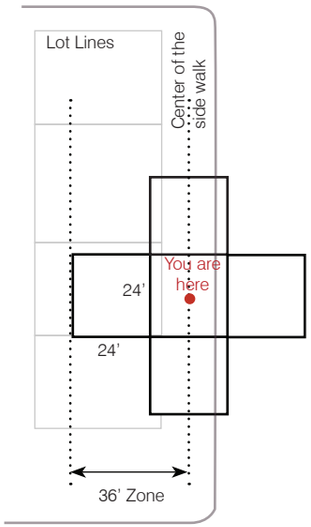


Figure 19: A block arrangement with 24' grid showing the 36' active zone

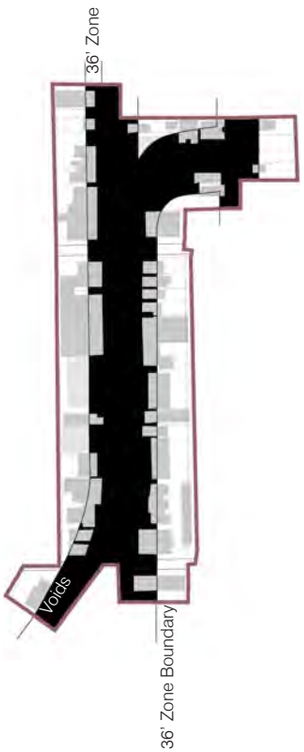


Figure 20: A step of calculations

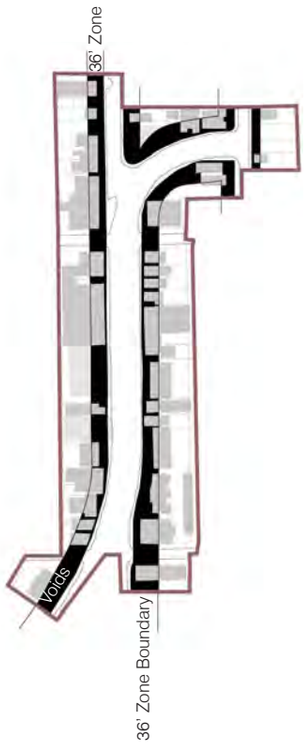


Figure 21: Street area is excluded from the calculations

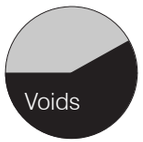


Figure 22: Overall result for Broadway Avenue 1: 58% of 36' zone is void.

Key

- Voids excluding street area
- Buildings
- Local neighborhood commercial district
- 36' zone boundary (offset from the center of the sidewalk)

open area in front of it or by occupying the entire front edge. Here the word "void" is used to mean anything other than a physical presence within the 36 foot wide zone; a void could be an empty lot, a parking area, an intersection of the main street with a secondary street, etc. Since this particular portion of the study is examining the physical edge condition, we exclude cases in which actively used voids are found (for example, a seating area in front of a restaurant). The final percentage is subtracted from 1 so that the ranking corresponds to other metrics.

Pc (V) is calculated for three main streets in the South Hills and three in the East End. Two sites - Downtown and East Liberty, were not calculated because the lattice nature of those areas made results difficult to compare with linear conditions. This is an area that requires more analysis.

Void calculations test a 3 dimensional variation on the edge calculations. What impact do open lots and stores pulled back from the build-to line have on connectivity? What is the impact of cross-streets and their width on connectivity?

Diversity

Diversity is the number of different NAICS code functions as a percentage of total patch count. This metric captures the variety of different functions within one main street. Is a wider variety a plus because more choices might draw more people, or is a narrower but deeper group of similar functions perceived as better?

Dominance

Dominance is measured by dividing the largest single NAICS code group by the total active retail patch count. This produces a percentage of all retail that fall into the most prominent functional group.

We tested each of these metrics against our Pc(A) calculation, our NM 24 neutral model and the Survey Rank benchmarks to see how each factor correlated to the different measures of connectivity. Higher correlations suggest that there is a strong relationship (>0.65 in our study) between the two factors, while weak correlations (< 0.35) suggest minimal relationship. Positive correlations mean that the factors rise or fall together, i.e. if income goes up as connectivity goes up, a positive correlation exists, while if income goes up and connectivity goes down the correlation is negative.

Community level metrics

We looked at some larger scale measures to test the impact of effects beyond the immediate main street environ on our connectivity analysis and to make sure that data from the South Hills was comparable to the East End. Using U.S Census and Pittsburgh Urban Redevelopment Authority data, we looked at key community economics and demographic factors including population, median household income, and percentage of home ownership at the community level. We also looked at the community's Walk Score[17], a popular composite index which takes numerous factors into account in developing a score from 1-100 with 100 being most walkable, to see if any of those correlated strongly with our Pc calculations or to our benchmark of Survey Rank and our Neutral Model NM Pc 24.

Walkability

This metric is taken directly from www.walkscore.com for each community. It is a composite of several metrics. You can read the methodology behind the score at www.walkscore.com/methodology.shtml. Effectively walkability is a measure of 'urbanity' – how pedestrian the area is.

Walkability correlates strongly (0.621) in a positive manner with the Survey Rank benchmark and insignificantly (0.020) with the Neutral Model benchmark. The Pc (A) has a moderate correlation.

[17] www.walkscore.com

Population, Owner Occupied % of households, and Median Household Income

These statistics[18] are taken from the Pittsburgh Urban Redevelopment Authority website. We used these three census based metrics to assess the impact of the community's wealth and total population and their affects on connectivity. Does higher household income and home ownership, which suggest more disposable income, drive main street connectivity? Is larger or higher density population a prerequisite for successful connectivity?

Average population over the entire data set was 8.912. Average household income was $ 45.245. Average home ownership percentage was 0.35.

Composite Pc 1 is developed by taking the average of the Pc (A), Pc (E) and Pc (V) for each site, weighted equally. It demonstrates that Pc is simply a ratio of the factors defining some biological function.

[18] See Chapter 6.4 Statistics for statistics taken from Urban Redevelopment Authority website at http://www.ura.org/business_owners/business_district_market_profiles.php

CORRELATION ANALYSIS	Survey Rank	NM Pc 24	Pc (A)
Total Patches	0.415	- 0.091	0.323
Active Retail Patches	0.604	0.101	0.530
Vacant Patches	0.119	- 0.415	- 0.008
Fragmentation Pc (O)	0.419	0.607	-0.39
Density	- 0.119	0.398	- 0.124
Dominance	-0.448	- 0.54	- 0.738
Voids %	- 0.803	0.885	- 0.676
Retail Storefronts Pc (E)	0.688	0.937	0.669
Diversity	- 0.395	0.937	- 0.334
Walkability	0.621	- 0.020	0.509
Population	0.737	0.311	0.435
Owner Occupancy %	- 0.782	- 0.424	- 0.705
Median Household Income	- 0.565	- 0.086	- 0.564
Retail % Pc (A)	0.825	0.742	
Composite Pc	0.846	0.576	0.878
Strong correlation (>0.65)			
Weak Correlation (<0.350)			

Figure 23: Correlation analysis results

These factors were chosen because of their consistently high correlations across the chart in the Correlation Analysis.

3.4 INTERESTING RESULTS OF THE CORRELATION ANALYSIS

The Survey Rank benchmark is strongly correlated to population, reinforcing a generalized sense that "people like to be around other people." Pc (A) goes up more slowly. It should be noted that the scale of Pc (A) and the Survey Rank are different, so comparing them directly needs to be done carefully as the scale difference may distort the magnitude of the correlations.

Household income has a moderate correlation to both the Pc (A) and the Survey Rank benchmark. What is surprising in our work is that this correlation is negative. The lower the median household income, the stronger/higher the Pc (A) and Survey Rank. Since the 'common knowledge' among retailers and brokers is that income determines retail success, the phrase 'follow the rooftops' appears to have limited value as a predictor of main street connectivity. The Neutral Model benchmark is completely insensitive to income, as expected.

Owner occupancy has a moderate negative correlation to the Pc (A) and a strong negative correlation to the Survey Rank benchmark. The strong correlation to owner occupancy suggests that communities with higher owner occupancy may be perceived as 'tight knit' or closed to outsiders, making visitors less comfortable and reducing the number of people on the street.

The number of retail patches has a strong positive correlation with the Survey Rank (.604) and Total patches slightly below that (.415). The Neutral Model has a weak correlation with all three count metrics, as expected.

Total Patch Count seems to have moderate correlations with both Pc (A) and the Survey Ranking.

Factors that have the strongest correlations (>0.650) to Survey Rank include, Voids (-) Pc (O), and Total Retail patches Pc (A) and storefronts Pc (E) (+). Larger scale factors include Population (+) and Owner Occupancy (-). Vacant units and Density correlates least strongly.

Factors that have the strongest correlation to Pc (A) include Voids (-) and Owner Occupancy (-)Dominance (-), Pc (E) storefronts (+). Pc(A) correlates least strongly with Vacant Patches,

Neutral Model Pc 24 correlates most strongly to Voids (-) and Retail storefronts Pc (E) (+). This is to be expected as both are functions of the matrix geometry, as is the Neutral Model. NM 24 correlates least strongly (<0.350) to Population, Walkability, Diversity, Total Patches (-) Pc (A) and Median Household Income, as expected.

3.5 OVERALL Pc COMPARATIVE ANALYSIS

We have looked at how Percolation Theory could be applied to an urban ecosystem, assessing the modules of the ecosystems structure and settling on a 24' module as the only one which generated Pc numbers limited to 0< Pc <1. We next considered the neighborhood rule – the context in which our analysis takes place. Both a 3 neighbor rule and a 5 neighbor rule seem viable, so we have not settled on one neighborhood rule. We have also collected and assessed numerous characteristics which may be factors in determining main street connectivity including counts of total patches, active retail patches and vacant patches, storefront edge and void data, density, diversity and dominance and other qualities to begin analyzing their impact.

These next tables show how this analysis comes together:

Sites sorted by Pc (A) with Survey Rank and neighborhood threshold results

	Composite PC 1	Pc (A)	Pc (E)	Pc (O)	Pc (V)	Survey Rank	Pc > .39	Pc > .50	Pc > .63
Walnut	0.612	0.9789	0.7560	0.9790	0.5800	9	Y	Y	Y
Bloomfield	0.602	0.9091	0.3670	0.9090	0.4100	8	Y	Y	Y
Downtown	0.6548	0.6548		0.8020		7	Y	Y	Y
Brookline 1&2	0.3764	0.5563	0.5730	0.9210	0.4800	5	Y	Y	
Broadway 1	0.2531	0.5333	0.2260	0.6670	0.4200	3	Y	Y	
East Liberty	0.2472	0.5116	0.2300	0.5120		6	Y	Y	
West Liberty	0.2053	0.4309	0.1850	0.6910	0.2600	1	Y		
Broadway 3	0.1962	0.2857	0.3030	0.8100	0.3400	2			
Brookline 3	0.1548	0.2174	0.2470	0.8700		4			
Average		0.5642							
Median		0.5333							

Pc (A) correlates well with both Survey Rank and NM Pc 24, but generates a higher than expected number of sites above the threshold Pc (three right hand columns on the table) for both Moore's (9 SQ) and Von Neumann's (5 SQ) neighborhoods.

Figure 24: Comparisons and correlations based on Pc (A).

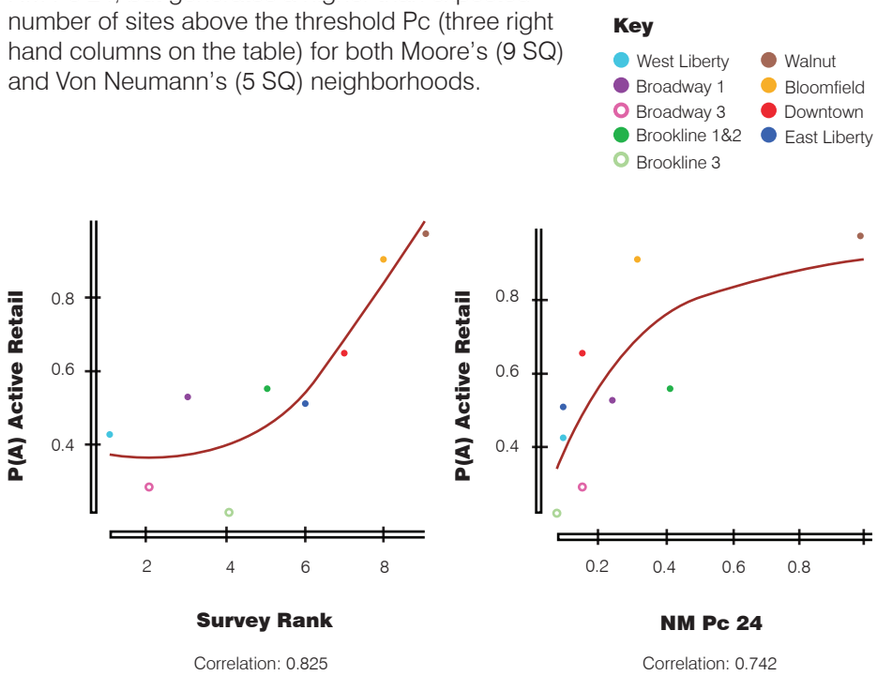
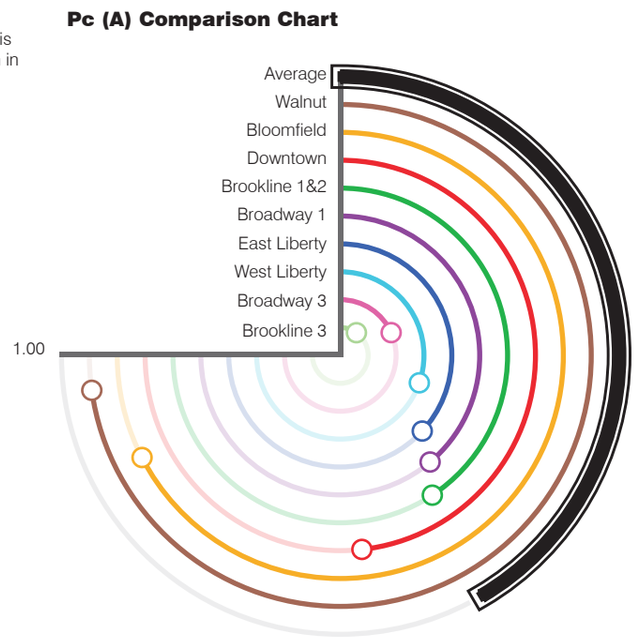


Figure 25: Comparison of Pc (A) for each focus area. Chart is created based on table shown in Figure 24.

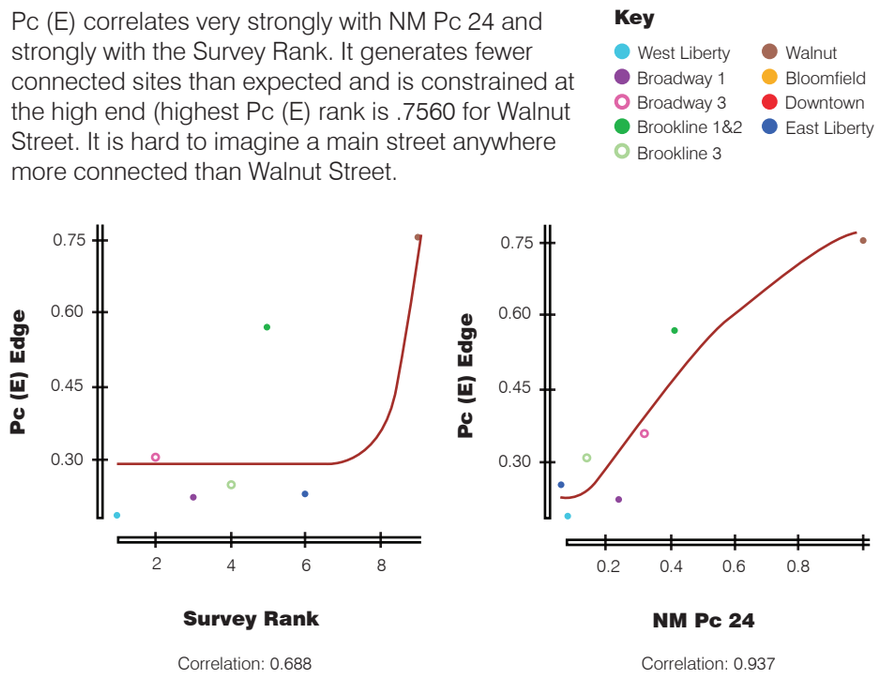


Sites sorted by Pc(E) with Survey Rank and neighborhood threshold results

	Composite PC 1	Pc (A)	Pc (E)	Pc (O)	Pc (V)	Survey Rank	Pc > .39	Pc > .50	Pc > .63
Walnut	0.6120	0.9789	0.7560	0.0210	0.4200	9	Y	Y	Y
Brookline 1&2	0.3764	0.5563	0.5730	0.0790	0.5200	5	Y	Y	Y
Bloomfield	0.6020	0.9091		0.0910	0.5900	8			
Broadway 3	0.1962	0.2857	0.3670	0.1900	0.6600	2			
Brookline 3	0.1548	0.2174	0.3030	0.1300		4			
East Liberty	0.2472	0.5116	0.2470	0.4880		6			
Broadway 1	0.2531	0.5333	0.2300	0.3330	0.5800	3			
West Liberty	0.2053	0.4309	0.2260	0.3090	0.7400	1			
Downtown	0.6548	0.6548	0.1850	0.1980		7			
Average			0.4920						
Median			0.5116						

Figure 26: Comparisons and correlations based on Pc (E).

Pc (E) correlates very strongly with NM Pc 24 and strongly with the Survey Rank. It generates fewer connected sites than expected and is constrained at the high end (highest Pc (E) rank is .7560 for Walnut Street. It is hard to imagine a main street anywhere more connected than Walnut Street.



Pc (E) Comparison Chart

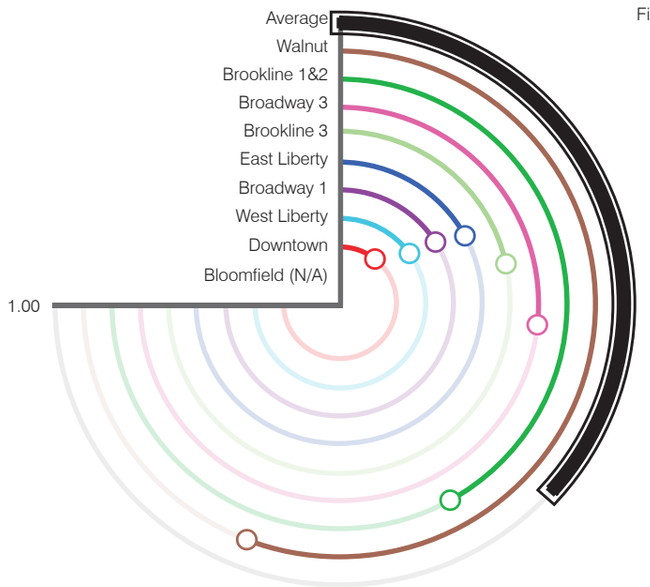


Figure 27: Comparison of Pc (E) for each focus area. Chart is created based on table shown in Figure 26.

Sites sorted by Pc(O) with Survey Rank and neighborhood threshold results

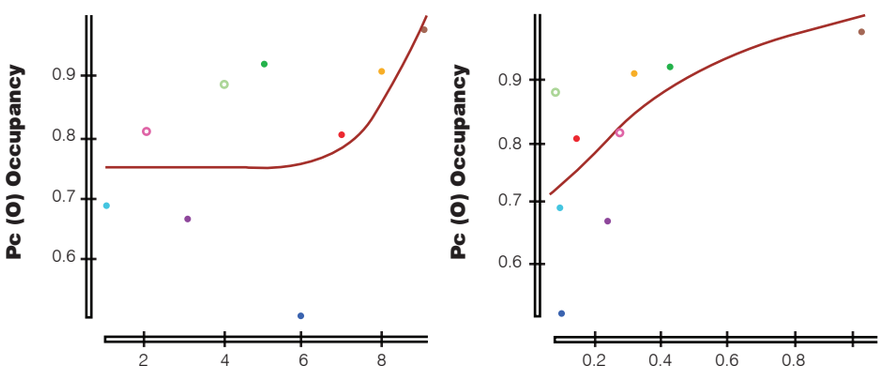
	Composite PC 1	Pc (A)	Pc (E)	Pc (O)	Pc (V)	Survey Rank	Pc > .39	Pc > .50	Pc >
Walnut	0.6120	0.9789	0.7560	0.9790	0.5800	9	Y	Y	Y
Brookline 1&2	0.3764	0.5563	0.5730	0.9210	0.4800	5	Y	Y	Y
Bloomfield	0.6020	0.9091	0.3670	0.9090	0.4100	8	Y	Y	Y
Brookline 3	0.1548	0.2174	0.2470	0.8700		4	Y	Y	Y
Broadway 3	0.1962	0.2857	0.3030	0.8100	0.3400	2	Y	Y	Y
Downtown	0.6548	0.6548		0.8020		7	Y	Y	Y
West Liberty	0.2053	0.4309	0.1850	0.6910	0.2600	1	Y	Y	Y
Broadway 1	0.2531	0.5333	0.2260	0.6670	0.4200	3	Y	Y	Y
East Liberty	0.2472	0.5116	0.2300	0.5120		6	Y	Y	
Average				0.7957					
Median				0.8100					

Figure 28: Comparisons and correlations based on Pc (O).

Pc (O) has a moderate correlation with the Survey Rank and NM 24 Pc, but is constrained at the lower end. All sites percolate in this analysis, and it is hard to imagine Broadway 3 or West Liberty Avenue being seen as connected.

Key

- West Liberty
- Broadway 1
- Broadway 3
- Brookline 1&2
- Brookline 3
- Walnut
- Bloomfield
- Downtown
- East Liberty



Pc (O) Comparison Chart

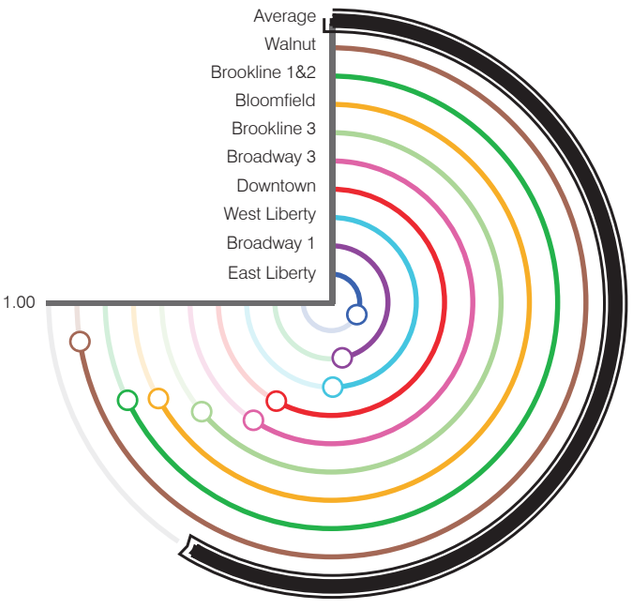


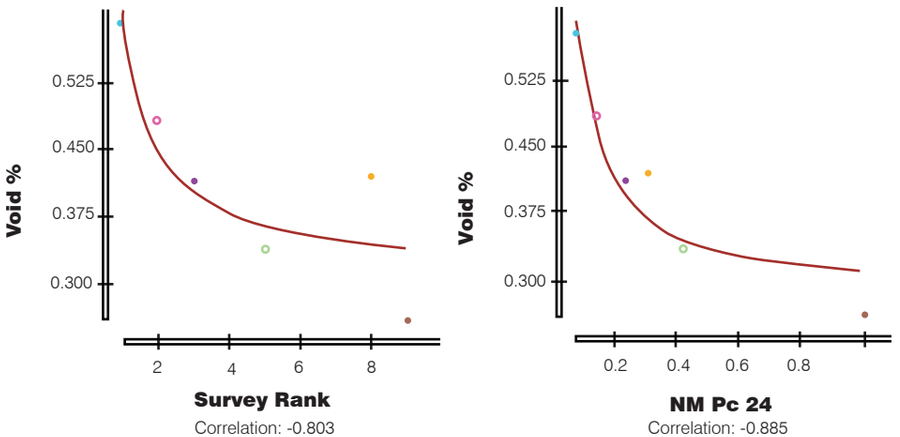
Figure 29: Comparison of Pc (O) for each focus area. Chart is created based on table shown in Figure 28.

Sites sorted by Pc(V) with Survey Rank and neighborhood threshold results

	Composite PC 1	Pc (A)	Pc (E)	Pc (O)	Pc (V)	Survey Rank	Pc > .39	Pc > .50	Pc >
Walnut	0.6120	0.9789	0.7560	0.9790	0.5800	9	Y	Y	Y
Brookline 1&2	0.3764	0.5563	0.5730	0.9210	0.4800	5	Y		
Broadway 1	0.2531	0.5333	0.2260	0.6670	0.4200	3	Y		
Bloomfield	0.6020	0.9091	0.3670	0.9090	0.4100	8	Y		
Broadway 3	0.1962	0.2857	0.3030	0.8100	0.3400	2			
West Liberty	0.2053	0.4309	0.1850	0.6910	0.2600	1			
Downtown	0.6548	0.6548		0.8020		7			
East Liberty	0.2472	0.5116	0.2300	0.5120		6			
Brookline 3	0.1548	0.2174	0.2470	0.8700		4			
Average					0.4150				
Median									

Figure 30: Comparisons and correlations based on Void %.

Pc (V) correlates strongly to both Survey Rank and NM 24 Pc, but the comparison to the actual ranking is well off the mark. At this point the analysis suffers from insufficient data since the lattice structures are not represented, so this option should be held in consideration until more data can be developed.



Pc (V) Comparison Chart

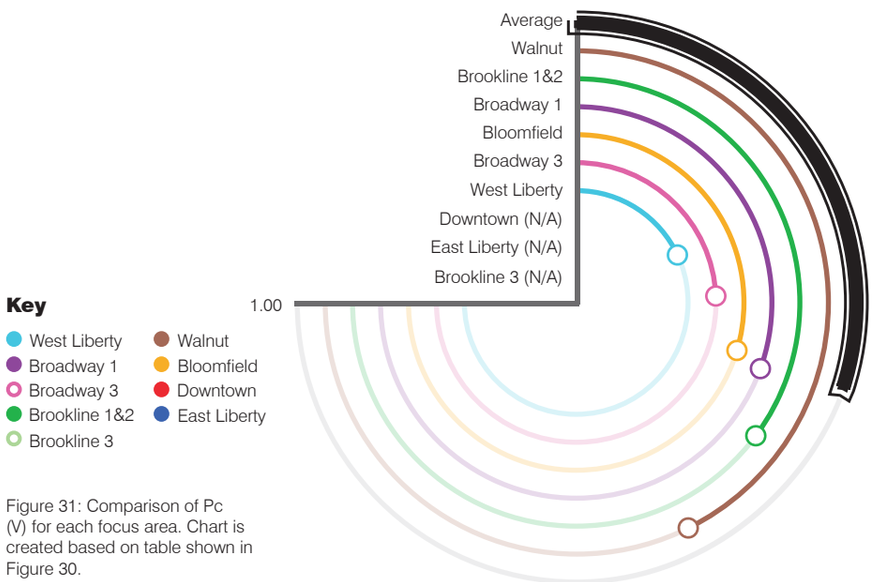


Figure 31: Comparison of Pc (V) for each focus area. Chart is created based on table shown in Figure 30.

Sites sorted by Composite Pc 1 with Survey Rank and neighborhood threshold results

	Composite PC 1	Pc (A)	Pc (E)	Pc (O)	Pc (V)	Survey Rank	Pc > .39	Pc > .50	Pc > .63
Downtown	0.6548	0.6548		0.8020		7	Y	Y	Y
Walnut	0.6120	0.9789	0.7560	0.9790	0.5800	9	Y	Y	
Bloomfield	0.6020	0.9091	0.3670	0.9090	0.4100	8	Y	Y	
Brookline 1&2	0.3764	0.5563	0.5730	0.9210	0.4800	5			
Broadway 1	0.2531	0.5333	0.2260	0.6670	0.4200	3			
East Liberty	0.2472	0.5116	0.2300	0.5120		6			
West Liberty	0.2053	0.4309	0.1850	0.6910	0.2600	1			
Broadway 3	0.1962	0.2857	0.3030	0.8100	0.3400	2			
Brookline 3	0.1548	0.2174	0.2470	0.8700		4			
Average	0.3669								
Median	0.2531								

Composite Pc 1 strongly correlates to the Survey Rank and moderately with the NM Pc 24. The ranking results match much better than Pc (V), and is not constrained at either the top or bottom end of the spectrum. It also generates results relative to the threshold affect within a range and ranking expected.

Figure 32: Comparisons and correlations based on Composite Pc 1.

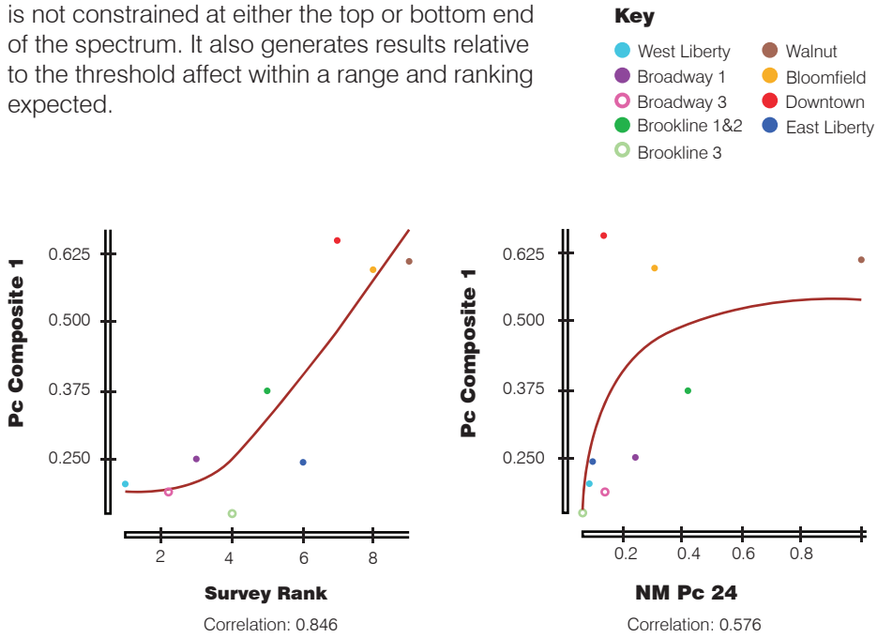
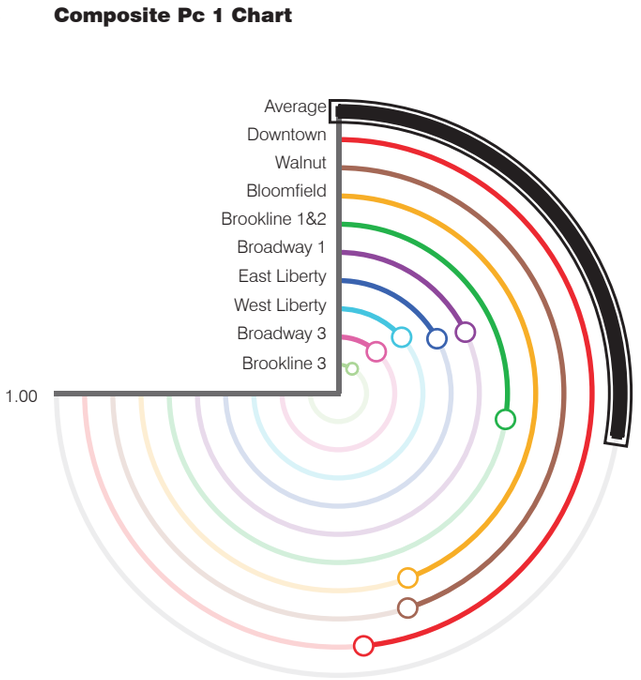


Figure 33: Comparison of Composite Pc 1 for each focus area. Chart is created based on table shown in Figure 32.



chapter 4

FOCUS AREAS

To this point, we have been focused on reading the data set across the rows to compare multiple sites to individual measures. Now, let us look at the columns to see what those measures tell us about each site. In this chapter we will focus on comparative data collected in three locations in the South Hills with data previously collected in Pittsburgh's East End and Downtown.

4.1 SOUTH HILLS

Any retail corridor contains its own history and evolution, and its patterns are shaped by a unique combination of underlying drivers. Therefore, it is worth examining the three focus areas in some depth before analyzing them through percolation theory, so that we may better understand the resultant patterns that have accrued over time.

All three corridors are located in the South Hills, a series of ridge lines in metropolitan Pittsburgh across the Monongahela River from Downtown Pittsburgh. The South Hills are composed of a series of individual neighborhoods that today can be collectively considered as part of a first-ring suburb. Two of them, Broadway Avenue and Brookline Boulevard, sit on the hilltop neighborhoods (Brookline and Beechview respectively) that flank the opening to the Liberty Tunnels, a major connection from the South Hills to the city. Running along the valley in between and forming this connection is the third corridor, West Liberty Avenue. While the three chosen retail corridors are geographically proximate, they are extremely different in character and form, each having been shaped by its own history and users.

The initial background information for these corridors and the surrounding neighborhoods was provided by the students of the Urban Lab studio in the fall of 2012. They analyzed current conditions through demographic analysis, history of the neighborhoods, current businesses and services, as well as recreational opportunities in the area. In this section, we have integrated portions of the students' study in order to understand the current conditions in Beechview and Brookline.

Figure 34: Focused main streets in South Hills.

Brief History

Like most cities and neighborhoods, Beechview and Brookline developed around key access corridors. The first streetcar lines were established in 1890 along Broadway Avenue and Brookline Boulevard, which opened up the area for residential development catering to those seeking to leave the more dense and polluted city center.[19]

Soon after, in 1905, additional trolley infrastructure, including three bridges and a tunnel, were constructed to support the tracks into Beechview and

[19] Audrey Iacone, Beechview, (Charleston, SC: Arcadia, 2005).

Figure 35: Development of study areas over time.

Brookline.[20] With the development of this highly efficient and accessible transportation system that linked to Downtown, residential development began to spread from Broadway Avenue and Brookline Boulevard outward into the two neighborhoods.[21,22]

In 1924, after five years of work and an investment of six million dollars, the Liberty Tunnels were opened, providing automobile access through Mt. Washington. This 5,800 foot long tunnel transformed what used to be a one to two hour commute to Downtown into an easy commute of less than ten minutes.[23] This rapid decrease in travel time encouraged further migration to Beechview and Brookline resulting in a rapid rate of growth for the neighborhood. New developments of the time were advertised as "like living in the suburbs, but only six minutes away from the city." [24]

As more and more people moved into Beechview and Brookline, a particular kind of culture began to flourish. These predominantly residential neighborhoods centered around their main streets, which contained many modest family-owned businesses in addition to community amenities such as schools, parks, playgrounds, pools, libraries, churches, and more.

As a result, the streetcar suburbs operated as a collection of small towns within the city limits. A great sense of pride and identity surrounded these communities as residents were able to connect around all that the neighborhoods had to offer.

Beechview and Brookline reached their heydays in the 1960s, when population peaked at around 15,000 and 20,000 people respectively. However, the streetcar suburb culture began to decline in the early 1970s.[25]

In Pittsburgh, as in many cities across the country, the decades immediately after World War II saw the rise of the interstate highway system and the beginnings of suburban sprawl. As they no longer needed to rely upon the streetcars and public transit for access to Downtown, city residents moved further out into the South Hills.[26] It was during this period that the Pittsburgh Port Authority was created, buying up thirty-two bus and incline companies as well as the Pittsburgh Railways Company and eventually phasing out Brookline's streetcar service.[27]

With the decline of the steel industry in the 1970s, many Pittsburghers found themselves without work, which resulted in a significant population decrease all across the city. At the same time, newly constructed suburban malls put pressure on many smaller family-owned businesses along Broadway and Brookline Boulevard, causing many of them to close their doors.[28] As a result of these changes, the hitherto close-knit neighborhoods lost much of their original population and found themselves without a strong sense of community identity.

Current Conditions

Following the collapse of the streetcar suburb culture in Beechview and Brookline, the population of both communities continued to decline at a consistent rate. This population drain led to a reduction in public transportation services and continues to present a challenge to local businesses, which in turn has diminished the attractiveness of the neighborhoods to potential incomers.

The demographics of Beechview and Brookline residents have shifted greatly over the last few decades. Beechview's current population is now only fifty-five percent of its peak population, while Brookline's population fared marginally better, at sixty-five percent.[29]

While there are still a number of families in the area, the population has aged significantly and many more retirees now reside in the area than previously. However, the majority in both neighborhoods are in their late twenties to mid-forties, suggesting that new groups of residents may be arriving. In a city with little immigration in the past few decades, these neighborhoods are notable for the number of new

[20] South Pittsburgh Development Corporation, Brookline, (Charleston, SC: Arcadia, 2005).

[21] Society for the History of Technology, Pittsburgh: A Brief History.

[22] Pittsburgh City Planning, PGHSNAP. "Neighborhoods: All Raw Data."

[23] Audrey Iacone, Beechview.

[24] South Pittsburgh Development Corporation, Brookline.

[25] Pittsburgh City Planning, PGHSNAP. "Neighborhoods: All Raw Data."

[26] Audrey Iacone, Beechview.

[27] South Pittsburgh Development Corporation, Brookline.

[28] Society for the History of Technology, Pittsburgh: A Brief History.

[29] "City of Pittsburgh Neighborhood Profiles, Census 2010 Summary File 1(SF1) Data," Program in Urban and Regional Analysis, University Center for Social and Urban Research, University of Pittsburgh, July 2011 p.99 and "Census 2000 Census Pittsburgh," City of Pittsburgh Department of City Planning p.4

residents who are coming from elsewhere. Easy access to downtown jobs (via public transportation or a drive down West Liberty) and inexpensive but solid housing stock (primarily single story stand alone homes with some townhouses and medium scale apartment buildings) have recently combined to make these neighborhoods attractive to immigrants and to young families alike.

Although though both share a growing popularity as starter home neighborhoods, the retail corridor through the center of each is extremely different, as is the car retail corridor that divides them: West Liberty Avenue.

Figure 36: West Liberty Tunnel connects West Liberty Avenue to Downtown Pittsburgh.

4.2 BROADWAY AVENUE

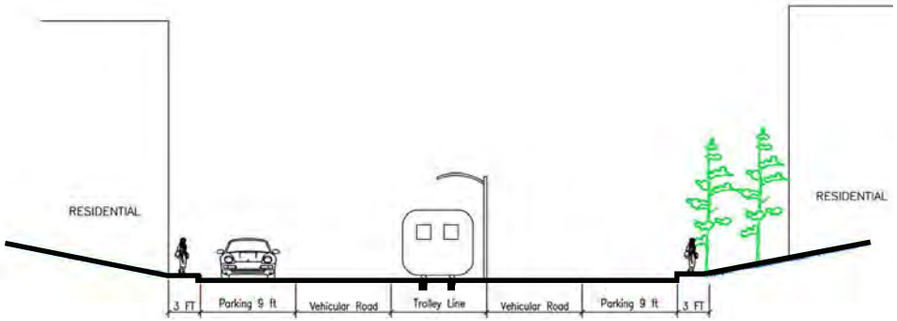
[30] http://www.carnegielibrary.org/locations/beechview/about.html Accessed 17 March 2012

Figure 37: The IGA on Broadway Avenue in Beechview.

Figure 38: Slice on Broadway Pizza Shop in Beechview.

Figure 39: Carnegie Library of Pittsburgh in Brookline.

Figure 40: Broadway Avnue typical street section.



Beechview has an extremely hilly landscape (it is home to Canton Ave, reputed to be the steepest street in the nation). Along the top of the ridge line sits the main retail corridor, Broadway Avenue. Here the light rail (the T) connects the neighborhood to Downtown, and to the more affluent South Hills towns of Dormont, and Mt. Lebanon.

Today Beechview is a residential neighborhood with a few small businesses, a new grocery store, eight churches, five parks, three schools, three senior residential complexes, a swimming pool, and a branch of the Carnegie Public library.[30] Most of these are located along Broadway Avenue.

The neighborhood is notable for being home to a rapidly growing Latino population. The neighborhood houses not only the Tienda Jimenez, a Mexican grocery, but also the Pittsburgh Metropolitan Area Hispanic Chamber of Commerce. In response to a local petition, St. Catherine of Siena Church offers a Spanish-language mass.

Nonetheless, the retail corridor is sporadic, interrupted on several occasions with residential fabric or vacant lots, leaving one with the sense that there are pockets of retail rather than a continuous retail corridor. There remain on Broadway a handful of businesses and community amenities to serve current residents, but the street lacks businesses that draw in visitors from outside the neighborhood. Residents must leave the community to obtain many of their most basic necessities.

Figure 41: Aerial view of Broadway Avenue.

Figure 42: Broadway Avenue is divided into 3 sections.

[31] URA, CityLiving, Market Profile: Broadway Avenue Commercial District.

The street currently contains four food and beverage stores (NAICS 445), including the Crested Duck Charcuterie Meat Market, and the Tienda Jimenez. A recently-opened IGA grocery store is currently struggling to remain open due to a lack of business. This despite the fact that, according to 2011 URA Market Research, based on demand, there is a $1.08 million deficit in food stores.[31]

Of all service and amenity markets, food services and drinking establishments (NAICS 772) are currently best addressing market demand in Beechview. The neighborhood has five such businesses including: the Huddle, Slice on Broadway, and Lunardi's.

A See Panaromic View on p.68

1 Mexican Grocery Store
2 Mexican Grocery Store
3 Alpine Bar
4 ESB Bank
5 Convinence Store
6 Bedrock Café / Bar
7 IGA Market on Broadway
8 Parking lot-temporary food
9 stands
10 General Cosmetic Dentistry
The Huddle Hot Wings (Restau-
11 rant Bar)
Becky's One Stop Shop Hair
12 Saloon
13 Thomas J. Oneill Attorney Law
14 PA State Senator Office
GC Auto Repair

1 Quality Cuts
2 Beechview Merchants Assos.
3 Brew Broadway Café
4 Crested Duck Charcuterie
5 Moose Lodge
6 Unique Pizza Factory
7 Beechview United Presbyterian Church
8 PC Auto Repair- Autobody and Mechanical Work
9 Tienda la Jimenez
10 Little JS' Publications Main Office

Key

Vacant store units

Local neighborhood commercial district

Figure 43: Units on Broadway Avenue 1

15 Carnegie Library of Pittsburgh
16 The Alteration Station Entrance
17 Laundry Mat and Café Shop
18 Casa Rasta(Taco Caribbean Fusion)
19 Chuck's Hair on Broadway
20 Lunardi's Ristorante
21 Davio Italian Cooking Restaurant
22 Slice on Broadway
23 Kara's Hair Design

11 St. Catherina of Siena Roman Catholic Church
12 William Eckels Funeral Home
13 Mercy Intellectual Disabilities Services

Figure 44: Units on Broadway Avenue 2

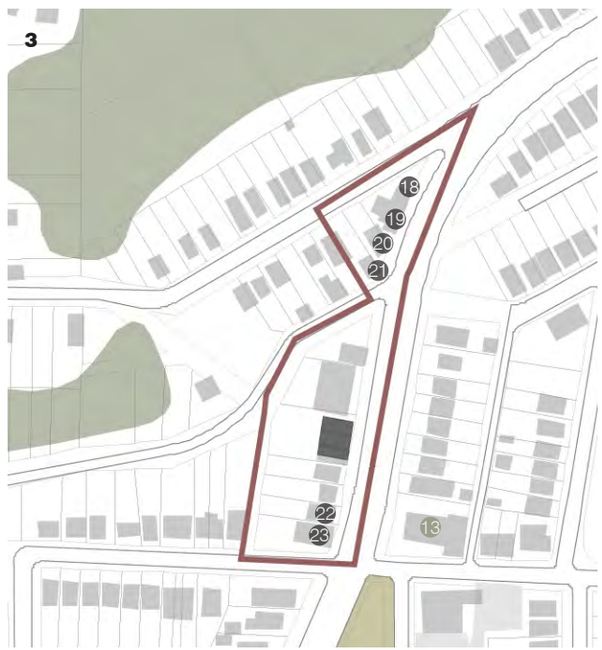
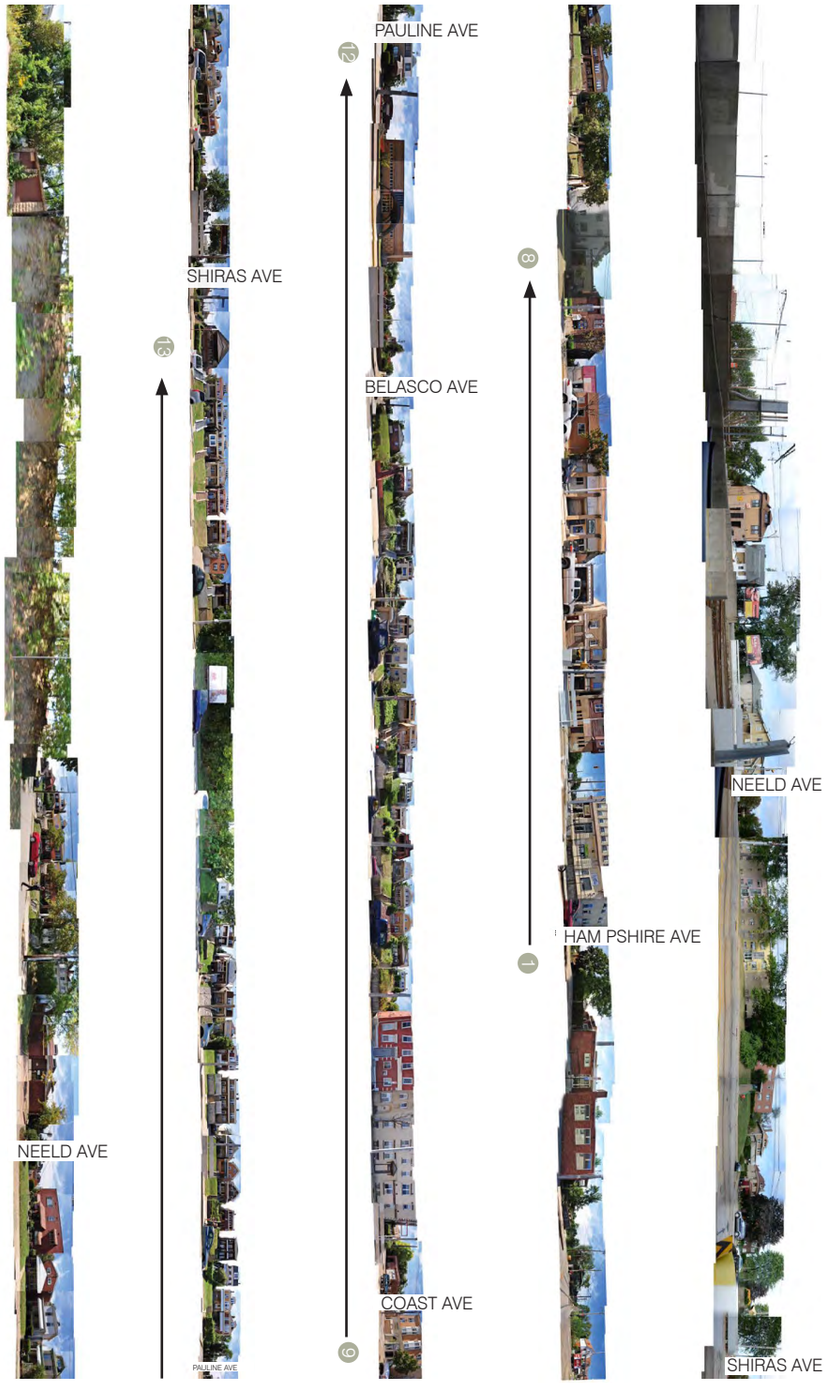


Figure 45: Units on Broadway Avenue 3

Figure 46 (on page 68 and 69): Broadway Avenue street facade. Numbers on street facade photos correspond to numbers on the plans.


NEELD AVE
SHIRAS AVE
PAULINE AVE
BELASCO AVE
COAST AVE
HAM PSHIRE AVE
NEELD AVE
SHIRAS AVE


SHIRAS AVE
CROSBY AVE
BOUSTED ST.
COAST AVE
COAST AVE
HAM PSHIRE AVE

Figure 47: Broadway Avenue retail types

Key

- Type A: Service
- Type B: General Merchandise
- Type C: Food, Beverage
- Type D: Cultural Entertainment
- Vacant Store Unit
- Non Retail

Findings

The survey rankings of these sites were Broadway 1-(3) and Broadway 3-(2). Only West Liberty Avenue, a strongly auto-centric corridor has a lower rank. Lower rankings represent a perception of lower connectivity.

The Neutral Model Pc is .2400 for Broadway 1 and .1200 for Broadway 3. Given the length of Broadway 1 (1200') and Broadway 3 (600'), and the facts that Broadway 3 has retail on only 1 side, they are equally structured and very low.

Density is actually higher on Broadway 3 - 10.5 units/acre verses 7.47 on Broadway 1, reflecting less empty lots on this shorter, one-sided street. Diversity was calculated for the entire street at .6, reasonably diverse (see Figure 48 and 49).

Pc (A) – Active Retail on Broadway 1 is .5333.

NAICS Distribution and Diversity
Broadway Avenue, Beechview

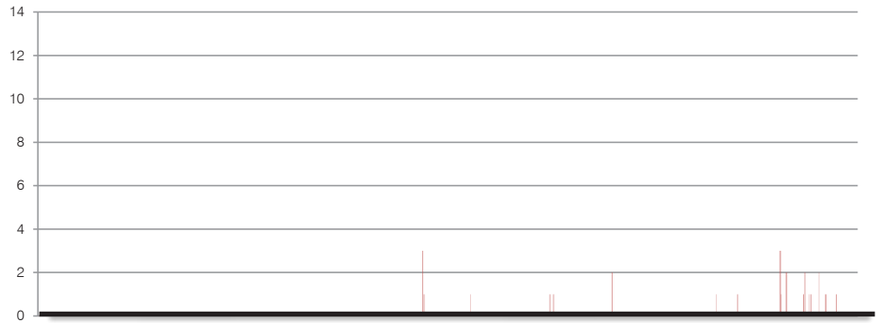


Figure 48: Broadway Avenue NAICS distribution and diversity

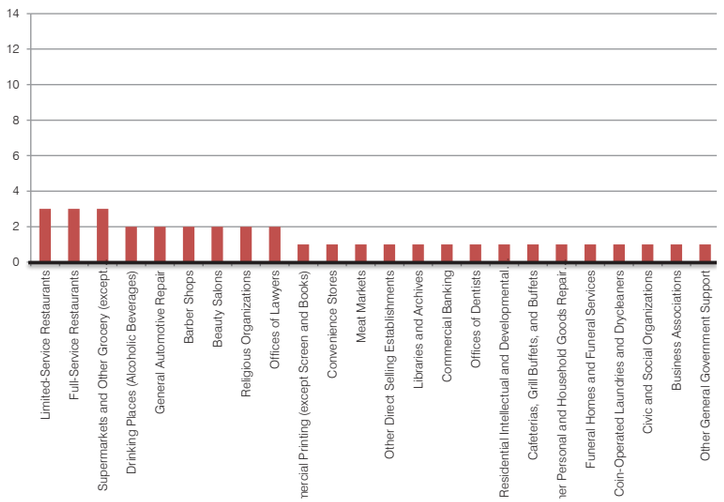
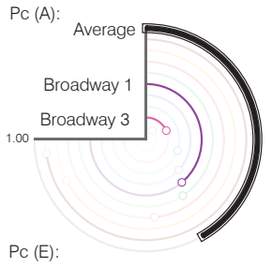
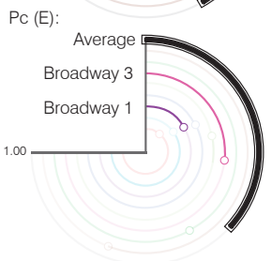


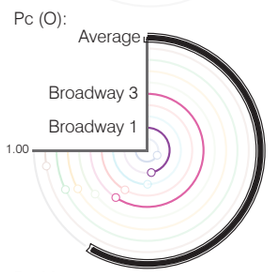
Figure 49: Broadway Avenue NAICS dominance sorted by NAICS type

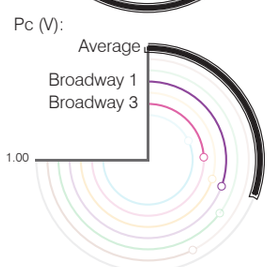
Broadway 3's Pc (A) is .2857. Broadway 1 has patches of retail coherence, but Broadway 3 is not a coherent retail area.

Pc (E) and Pc (V) indicate that there are not strong edges to either section of the street. Our overall analysis shows these to be very significantly correlated to perception of connectivity.









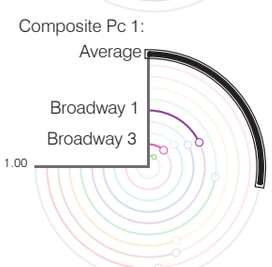


Figure 50 (top): Broadway Avenue Pc Values

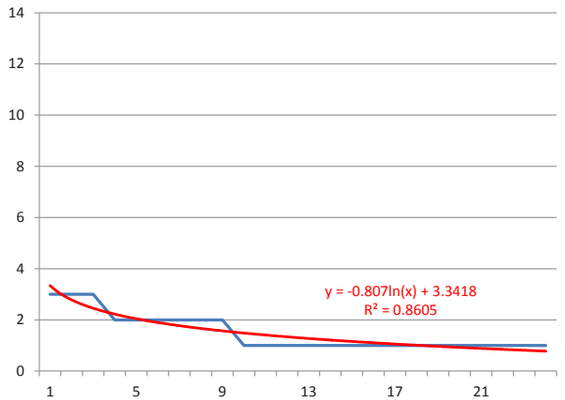
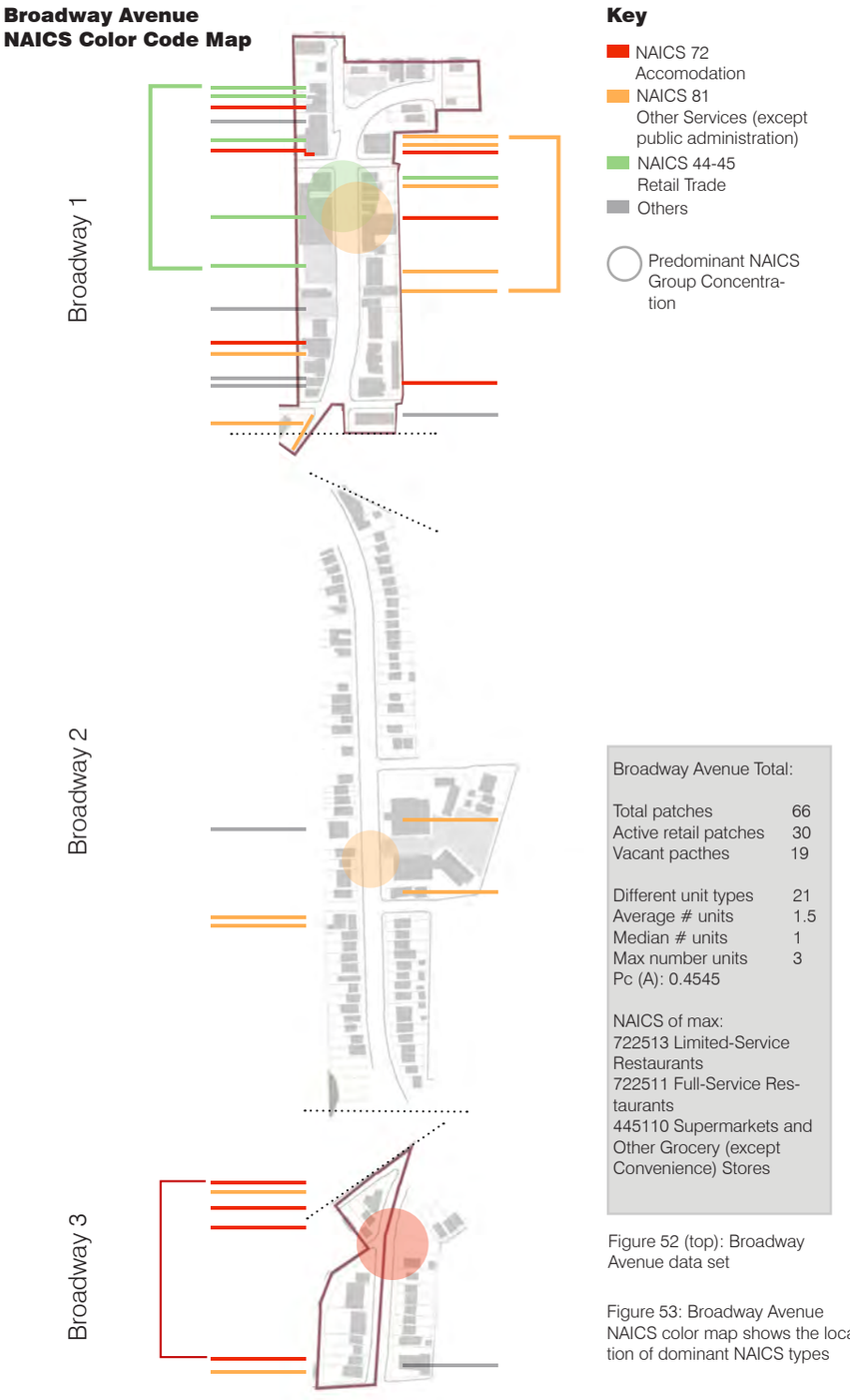


Figure 51 (top right): Broadway Avenue patch count distribution

Pc (O) - Fragmentation indicates Broadway 3 has a higher fragmentation at .81 and Broadway 1 at .667, but the small size of Broadway 3 makes this measure more volatile and less meaningful.

Broadway is not connected. Some of those factors are outside the physical structure of Broadway: Beechview has the lowest population numbers of any of the study sites, and one of the highest owner occupancies, both have strong negative correlations to perceptions of connectivity.

Densification through infill site development would improve the perception of connectivity somewhat. Taking advantage of the voids and open spaces along Broadway, infill would strengthen the streets structure. Additionally, a recruitment program to strengthen the Latino cultural presence of the food centric mix would help in giving the area a focus for customers.



Broadway Avenue Total:	
Total patches	66
Active retail patches	30
Vacant pacthes	19
Different unit types	21
Average # units	1.5
Median # units	1
Max number units	3
Pc (A): 0.4545	

NAICS of max:
722513 Limited-Service Restaurants
722511 Full-Service Restaurants
445110 Supermarkets and Other Grocery (except Convenience) Stores

Figure 52 (top): Broadway Avenue data set

Figure 53: Broadway Avenue NAICS color map shows the location of dominant NAICS types

4.3 BROOKLINE BOULEVARD

Though less steep than Beechview, Brookline is also a neighborhood characterized by a hilly topography. While the trolley line that ran down its main street was discontinued decades ago, it still has the feel of a streetcar suburb, with gently sloped roads of single-family homes occupying much of the built fabric.

Brookline has weathered Pittsburgh's post-steel decline slightly better than Beechview. Its population shrank at a slower rate, and today it is the second largest neighborhood in the city. Its main street, Brookline Boulevard, remains fairly intact, although the types of stores have changed over the years. While there are still a number of family-owned businesses, the national chains are beginning to appear as well.

Interestingly, Brookline Boulevard is a one-sided retail corridor: only the southwest side of the street contains shops, while the northeast side is mainly populated by residences, with the occasional shop built out in the front yard. This may have to do with the grade change of the plots from one side of the street to the other. Also, because the streetcar rails are gone, the street is unusually wide. As a result, cars are able to park head on facing the stores on the southwest side, giving the street the feel (and ease) of a suburban strip mall.

Figure 54: Brookline Boulevard typical street section

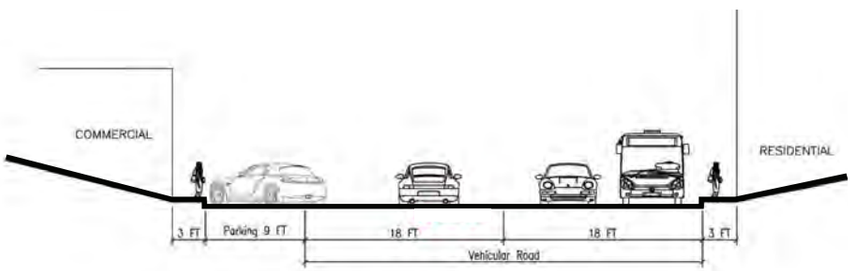


Figure 55: Aerial view of Brookline Boulevard

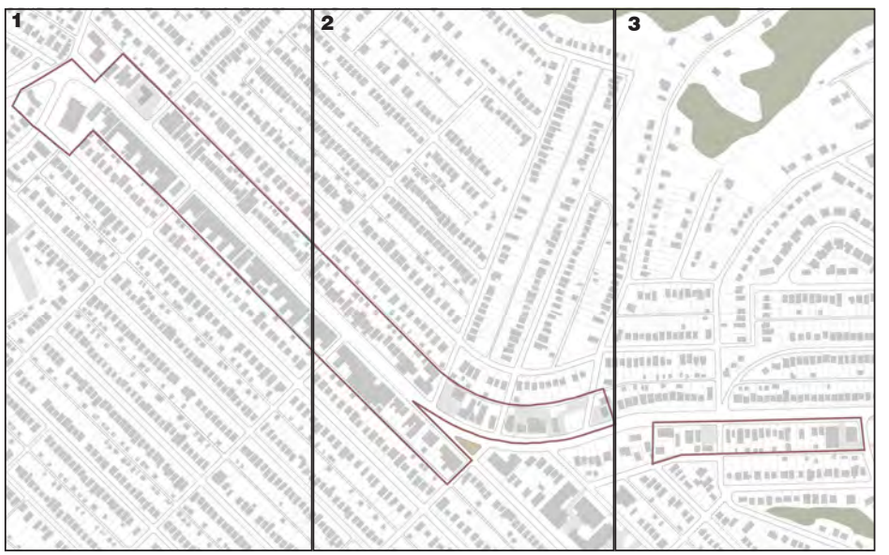


Figure 56: Brookline Boulevard is divided into 3 sections.

[32] URA, CityLiving, Market Profile: Broadway Avenue Commercial District.

There are a number of successful businesses on the boulevard, and the demand for additional commercial investment is attractive to businesses owners. While the area contains some businesses with an appeal to visitors in addition to serving residents, there is an opportunity to strengthen this aspect.

Brookline has fourteen food service and drinking establishments. Several of these businesses have begun to attract visitors from outside the neighborhood (including Las Palmas and their now city-renowned tacos). According to market research, however, there remains a $4.2 million gap in demand for food service and drinking businesses industries in this neighborhood.[32]

Findings

The survey rankings for Brookline 1 & 2 and Brookline 3 (fifth and fourth respectively) indicate better perception of these corridors than either of the Broadway sites, and represent the midpoint of the survey rank.

The Neutral Model Pc shows significant change between the two sections of Brookline Boulevard. NM Pc of .4200 for Brookline 1&2, and .0674 for Brookline 3 indicate that Brookline 3 is significantly less well structured. Reading the plan, this portion of the street appears to be composed primarily of converted residential structures, given the deeper setbacks from the street and the vacant strips separating the structures. This is confirmed in the field survey. Brookline 1&2 on the other hand, has seen significant infill with more commercial typologies with storefronts build to the sidewalk, and little to no side-yard. Its NM Pc reflects the wider than normal street (51' storefront to storefront), as well as the residential nature of the northeast side of the street.

Density is about the same between Broadway 1 (7.47) and Brookline 1&2 (7.31). It is lower on Brookline 3 at 5.75. Diversity was similar between both segments of Brookline Blvd. and similar to Broadway.

Pc (A) – Active Retail on Brookline 1&2 is solid at .5566, but Brookline 3 is a weak .2174 indicating that Brookline 3 is less a retail corridor than an overflow/low cost growth area.

Pc (E) and Pc (V) reflect the better definition of the southwest street wall on Brookline Blvd 1&2. If the north side of Brookline 1&2 was not composed of mostly residential typologies, the Pc (E) and Pc (V) would be stronger.

Pc (O) - Fragmentation indicates minimal fragmentation on both segments of Brookline Blvd, and explains to some extent the push north across the street sections 1&2 - Pc (O) = .921, as well as down the street into section 3 whose Fragmentation Pc is .87.

Brookline 1&2 is near the threshold of connectivity but the composite Pc 1 suggests that more work is required to reach the threshold level. As a composite of retail activity, voids and street edges, this metric indicates a need for greater infill along Brookline 1&2. If the north side of the street was to continue its transformation from residential typologies to commercial ones, the street would become a stronger commercial corridor. If at the same time some identity was to develop (as reflected by an increase in Dominance measure), this street has the potential to become a center for the entire South Hills area for more discretionary retail excursions. Alternatively, it could remain the neighborhood main street that it is, and strengthen the one-sided retail corridor with a few improvements to the street section (such as wider sidewalks and a narrower vehicular right of way to accommodate outdoor seating, pedestrian and bike lanes).

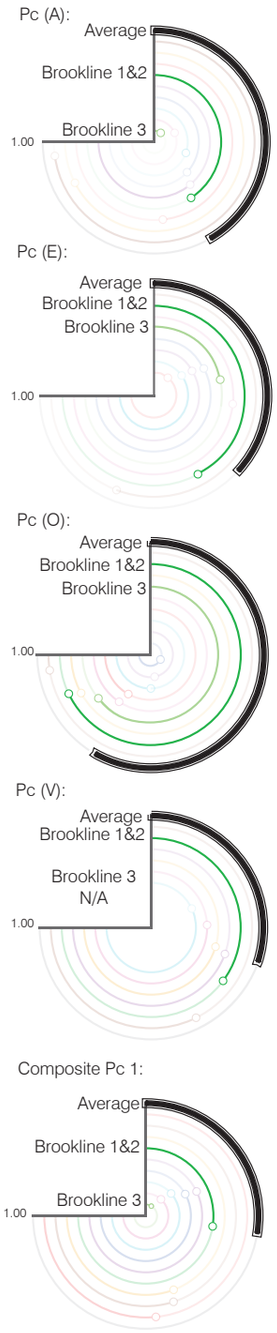


Figure 57: Brookline Boulevard Pc Values

Figure 58: Units on Brookline Boulevard 1

Key

Vacant store units

— Local neighborhood commercial district

1. MJ Automotive Service Center
2. CVS
3. American Legion Post
4. Lovely Massage
5. The Medicane Shoppe Pharmacy
6. Jo's Salon
7. Moonlite Cafe Italian Cuisine
8. Cell Phones and more Professional Phone Flashing & Unlocking, Full Bill Payment Cnter Computer Repair
9. Geekdrome Games & Comics
10. No name Luncheonette
11. Barber Shop
12. Zippy's Saloon Grandma's Kitchen - Daily Lunch & Drink Specials
13. Kribels Bakery
14. Tisha's Sunny Farms Deli
15. US Post Office Brookline Station
16. Betz Auto Works
17. Jacqueline's House of Beauty Day Spa Salon
18. Mazza Shoes & Shoe Repairing
19. Vinny's Pizza & Pasta
20. PitaLand
21. Fire House
22. Las Palmas Mexican
23. South Hills Printing
24. Party Cake Shop
25. Carnegie Library of Pittsburgh
26. Sal's Barber Shop
27. Alterations by Rina
28. Community Bank

29. Mateo's Cucina Italiana
30. Joseph Antar's Salon
31. Wines & Spirits
32. Boulevard Laundramat
33. Cricket
34. Brookline Pub
35. The Sanctuary in Pittsburgh
36. Magisterial District Judge
37. Tatto Place
38. Thrift Store
39. Cut's Styles
40. Saloon Cristianna
41. Vinnie's Pretzel Shoppe
42. Antonie Pizzeria
43. Melissa Destel Photography
44. Cannon Coffee
45. Sun's Intanity
46. Gordon's Restaurant and Lounge
47. CompiLink Networks Inc.
48. Decio's Custom Tailoring Men & Ladies' Alterations Tuexedo Rental and Sales
49. Anna Nails Design

1. Salon Canova
2. Daisies Child Development
3. Medi-Help Family Practice Medicine
4. Sunoco gas station and store
5. Brookline Assembly of God
6. Brookline Plumber
7. Family Dentistry
8. Scoops On the Boulevard (Ice Cream)
9. Boulevard Tobacco Outlet
10. Chiropractor Dr Reschenthaler

Key

Vacant store units

— Local neighborhood commercial district

Figure 59: Units on Brookline Boulevard 2

50 PNC Bank
51 Erin Molchany, Democrat for State Representative
52 State Representative's Office
53 Fox's Pizza
54 Hair by Conroy
55 Brookline Deli
56 Privi Vault Collections Designer Brand Clothing and accessorizes for the whole family
57 Attorney at Law (Accounting and Tax Services)
58 PA State Senator Office
59 A-Boss Opticians
60 Chuong's Cleaners / Dry Cleaning, Laundry Shirts, Alterations and more
61 S.N. Glass Mirror
62 Tong Garden Chineese Restaurant
63 Armond's Frame Shop
64 Exercise Saloon

65 Brookline Lounge
66 Jr's Sports Bar
67 Century Cleaners
68 Cinema Consultants & Services International
69 Marshall's Lounge

11 Ambros Tv Services Repairs
12 LDC Properties company office
13 McAfee & Lynch Antiques
14 Brookline Produce (Lunch Meats and Cheeses)
15 Brookline Chiropractic Center
16 Rugs 4u
17 Garcia's Cut-Off Family Hair Care
18 Sales, Property Management Consulting
19 Chinease Body Works
20 Hanks Too
21 PA WorldWide Travel (Airlines Tickets, Rental Cars, Cruises)
22 Brookline Podiatry Foot Ankle Specialist
23 The Violet Bouquet Flower Shop (Wedding Flowers)
24 St Mark's Lutheran Church
25 CoGo's Store
26 It's Greek to me (Delicious Greek Food) Greek International Eat, Live, Love
27 Italian specialty & Gourmet catering brookline

28 South Hills Art Center
29 Brookline Beer Distributor
30 Preferred Primary Care Physicians INC
31 Micheal Clements M.D. Family Practice
32 DeBor Funeral Home
33 Gas Station and 7 Eleven

Key

Vacant store units

Local neighborhood commercial district

Figure 60: Units on Brookline Boulevard 2

Figure 61: Brookline Boulevard retail types

Key

Type A: Service
Type B: General Merchandise
Type C: Food, Beverage
Type D: Cultural Entertainment
Vacant Store Unit
Non Retail

Figure 62 (on page 82 and 83): Brookline Boulevard street facade.

21 ← 2

44 ← 22

56 ← 45

64 ← 56

1 → 7

8 → 12

13 → 24

25 → 33

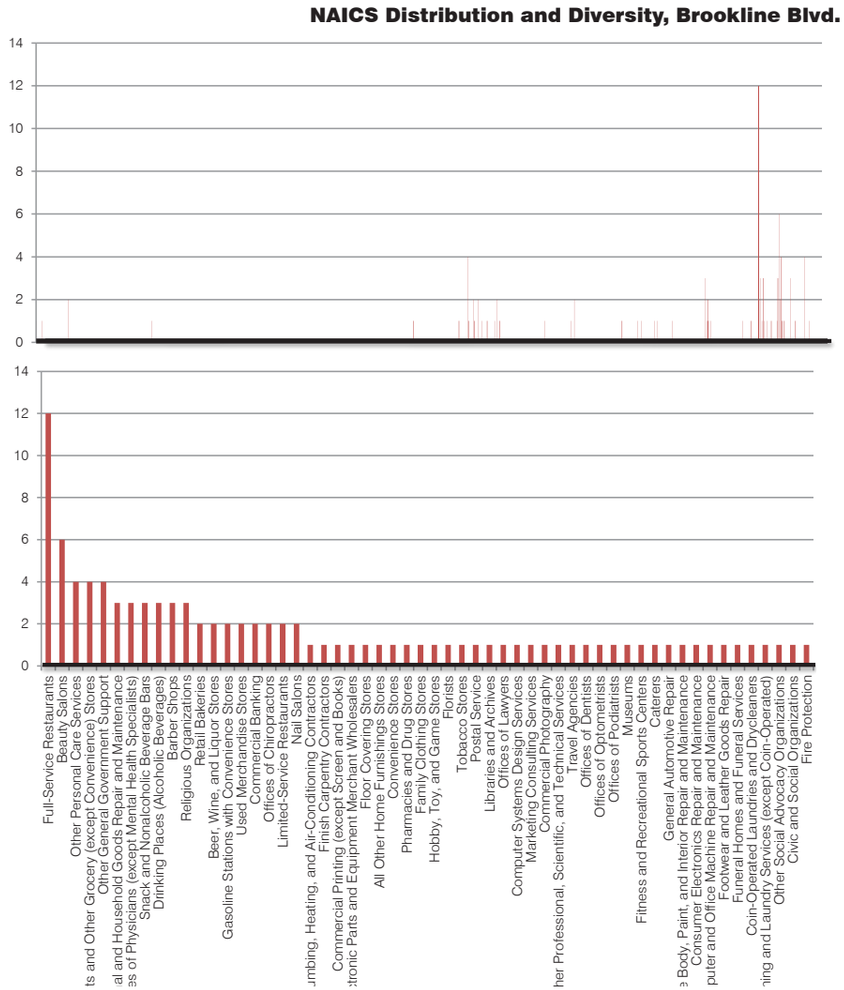


Figure 63 (top): Brookline Boulevard NAICS distribution and diversity

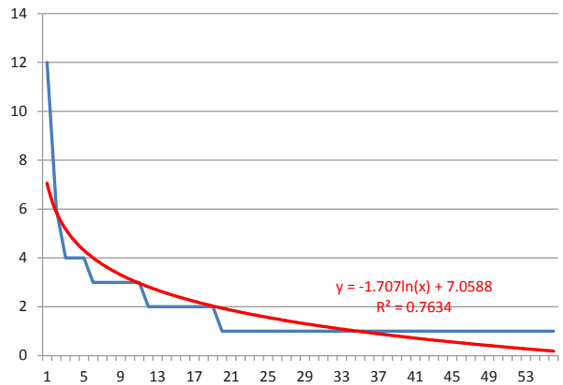
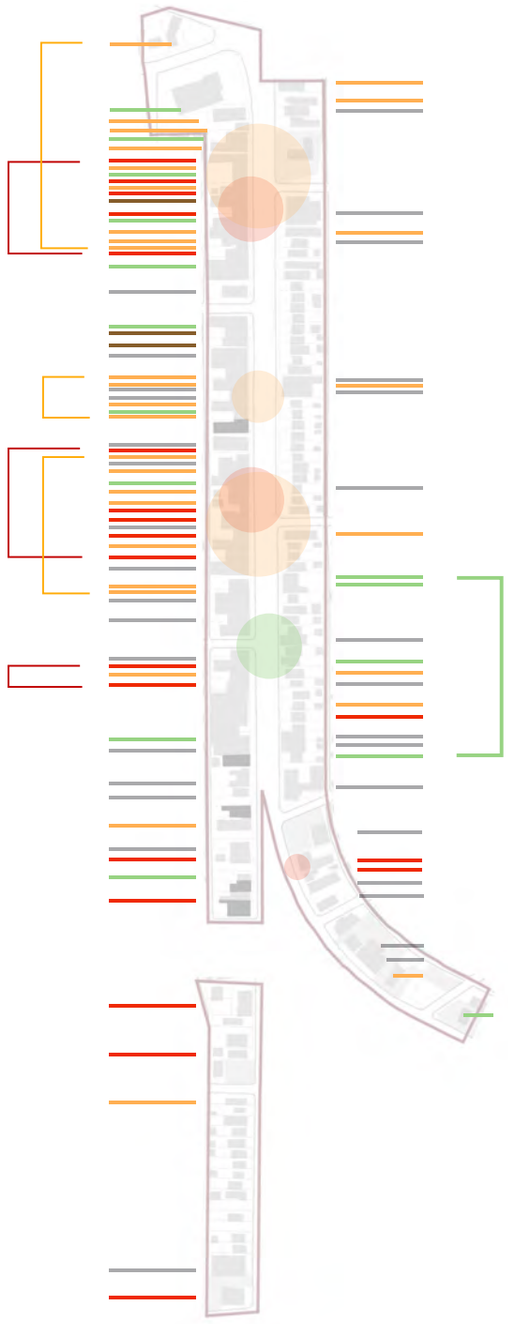
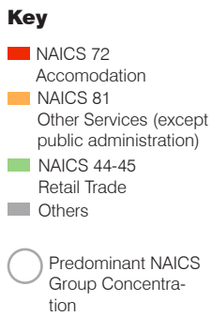


Figure 64 (middle): Brookline Boulevard NAICS dominance sorted by NAICS type

Figure 65 (bottom): Brookline Boulevard patch count distribution





Brookline Boulevard Total	
Total patches	174
Active retail patches	89
Vacant Patches	15
Different unit types	52
Average # units	1.8
Median # units	1
Max number units	12
Pc (A): 0.5114	
NAICS of max: 722511 Full-Service Restaurant	

Figure 66 (top): Brookline Boulevard data set

Figure 67 (top left): Brookline Boulevard NAICS color map shows th location of dominant

4.4 WEST LIBERTY AVENUE

In the valley that divides the hilltop neighborhoods of Beechview and Brookline lies West Liberty Avenue, an essential link in the transit system which supports U.S. Route 19 and connects Pittsburgh's Downtown to affluent and populous suburbs in the South Hills. The various neighborhoods, municipalities, boroughs and townships which make up the South Hills region are home to over 295,000 people (or roughly thirteen percent of the population of the greater Pittsburgh region) and the corridor plays an important role in connecting people with their workplace, and thereby enabling a commuting culture.

In addition to acting as a major bridge between the outlying suburbs and the inner rings of the city, West Liberty Avenue currently functions as a automotive-oriented retail strip. Known across the city for it numerous car dealerships, West Liberty Avenue is characterized by object-building stores surrounded by asphalt (part parking lot, part show room). Because it is organized along a main transit artery, it relies heavily on the use of billboards and other signage to attract the high-speed commuter/consumer. Traffic typically moves rapidly (except during rush hour) and, as the landscape is scaled to the rapidly moving automobile, little to no pedestrian oriented space exists; it is not uncommon for sidewalks to end abruptly.

Currently, West Liberty is dominated by automobile dealerships and occupies an important regional commercial niche for automobile sales. The dealerships are an economic driver, but due to its location within a narrow valley, and the large areas of surface parking, the corridor gives an appearance of dereliction and abandonment. A number of fast food restaurants are also located on the road, which further contributes to it "honky-tonk" character.

In a sense West Liberty Avenue functions not only as a transit-oriented strip for the region, but also as a boundary between the communities of Brookline and Beechview; it acts as both an urban "wall"

Figure 68: Aerial view of West Liberty Avenue

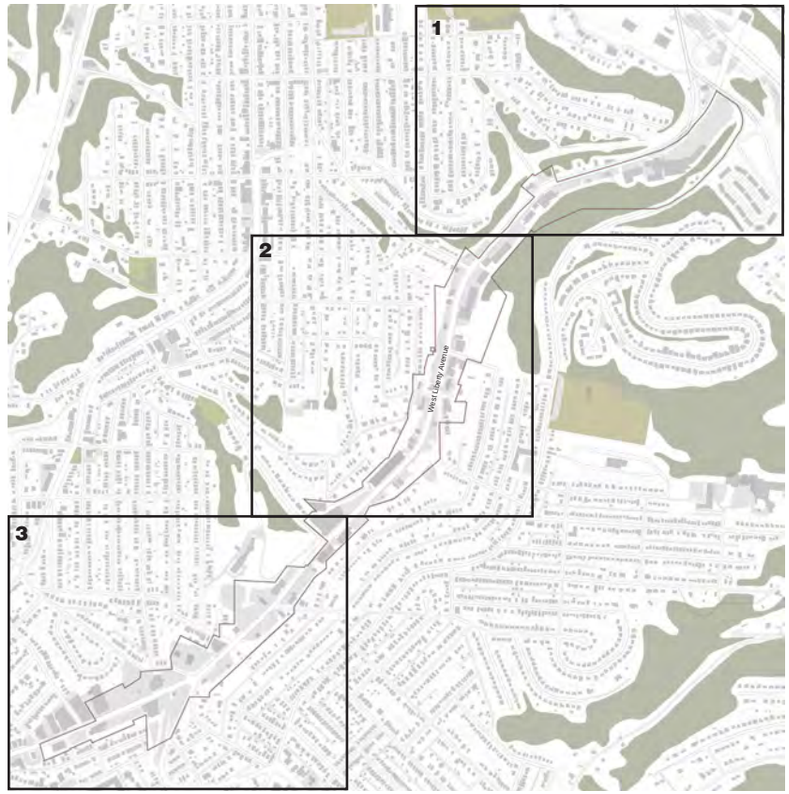


Figure 69: West Liberty Avenue street parts

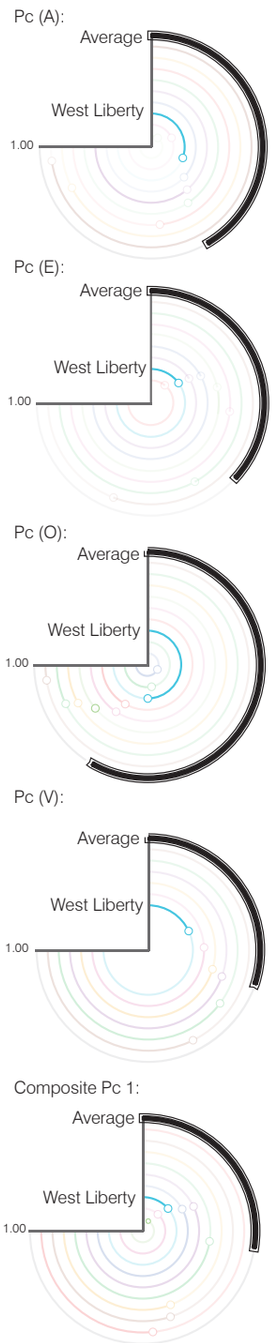


Figure 70: Brookline Boulevard Pc Values

restricting the flow between the adjacent neighborhoods and as a "tunnel" to those who use the highway for transit through it.

Findings

The survey ranking for West Liberty Avenue was 1, meaning it is perceived as the least connected corridor in the survey. What is interesting is how the other metrics support, or do not support that perception. In spite of its honky-tonk appearance, West Liberty Avenue has a Walkscore higher than either the Beechview or Brookline neighborhoods on either side of it.

The Neutral Model Pc for West Liberty Avenue reflect its object sized buildings and asphalt landscapes. At an NM Pc of .0766 – its structure is very broken, but not the lowest – Brookline 3 actually has a lower NM Pc at .0674.

Density is again low at 2.15 units/acre, but not the lowest, which was East Liberty at 1.92 units/acre. Given the large scale of the auto dealerships and car repair facilities along West Liberty, this is actually stronger than expected. Diversity was in the mid-range, slightly higher than average for the set, but slightly lower than the median.

Pc (A) – Active Retail (.4309) is below average (.5642) and median (.5333), but again higher than for Brookline 3 (.2174), and Broadway 3 (.2857).

Pc (E) at (.1850) and Pc (V) at (.2600) reflect the big box, auto centric nature of the typology.

Pc (O) – Fragmentation (.6910) indicates the West Liberty Avenue is reasonably coherent – it has higher Pc(O) than Broadway 1 or East Liberty.

Composite Pc 1 ranks West Liberty Avenue higher than Broadway 3 (.1962) and Brookline 3 (.1548).

1. Gery Heating & Cooling
2. The Clock Shop Sales & Service
3. Knight Motors
4. Paul's Automotive Service
5. Newman Motors Inc.
6. Castriota Chevrolet Inc.
1. Matthews International Corporation Bronze Division
2. Beer & Tobocco West Liberty
3. Subway
4. Advance Auto Parts
5. Steller Generator Sales & Service
6. Realtors Association of Metro-
7. politan Pittsburgh Dean Tech
8. R.A.S Auto Detail
9. J.D. Byrider
10. Unidentified (previously Castriota, Chevrolet, INC.)

Figure 71: Units on West Liberty Avenue 1

Key

Vacant store units

Local neighborhood commercial district

Figure 72: Units on West Liberty Avenue 2

Key

- Vacant store units
- Local neighborhood commercial district

7. Atlas Transmissions Inc.
8. Gery Automotive LLC.
9. Sewing Machine, Vacuum Cleaner Repair
10. Enterprise rent-a-car
11. M.a.d Alessandro Automotive
12. Unidentified
13. Rohrich Toyota Scion
14. Rohrich Cadillac (Under renovation)
11. Bentley Pittsburgh
12. Auto Paint Repair (being renovated currently)
13. Auto Parts
14. Norm Weiss Automotive Service
15. Art Craft Mantel & Fireplace Co. Inc.
16. Fueland Inc.
17. Slicks Bar
18. Fiori's Pizzaria
19. Mike Nahm Plumbing
20. Le Cupcake Shop
21. West Liberty Glass
22. Toyoto Certified Used Vehicles
23. Wholesale Auto Detail
24. Martin Auto Sales
25. Rohrich Lexus

15. Subaru Service
16. Wendy's
17. Rohrich Automotive Group
18. Cent Annis Lounge/Restaurant
19. Senor Frogs
20. Mc Donald's
21. Beinhauer Funeral Home-Crematory
22. Rohrich Cadillac and Chevrolet (Temporary Location)
26. Dominick Racecar Fabrication
27. Rohrich Lexus
28. Rohrich Cadillac Authorized Dealer Used Cars
29. Used Car World of West Liberty
30. Dona telli Cemetery Memorials
31. Krazy Brothers Pizza
32. George Uniform Co. Postal, Fire & Police
33. Three Rivers Chryseler Jeep Dodge, LLC
34. Terry Key Auto Detailing
35. Rohrich Cadillac Chevrolet
36. West Liberty Cycles
37. Under Construction

Figure 73: Units on West Liberty Avenue 3

Key

- Vacant store units
- Local neighborhood commercial district

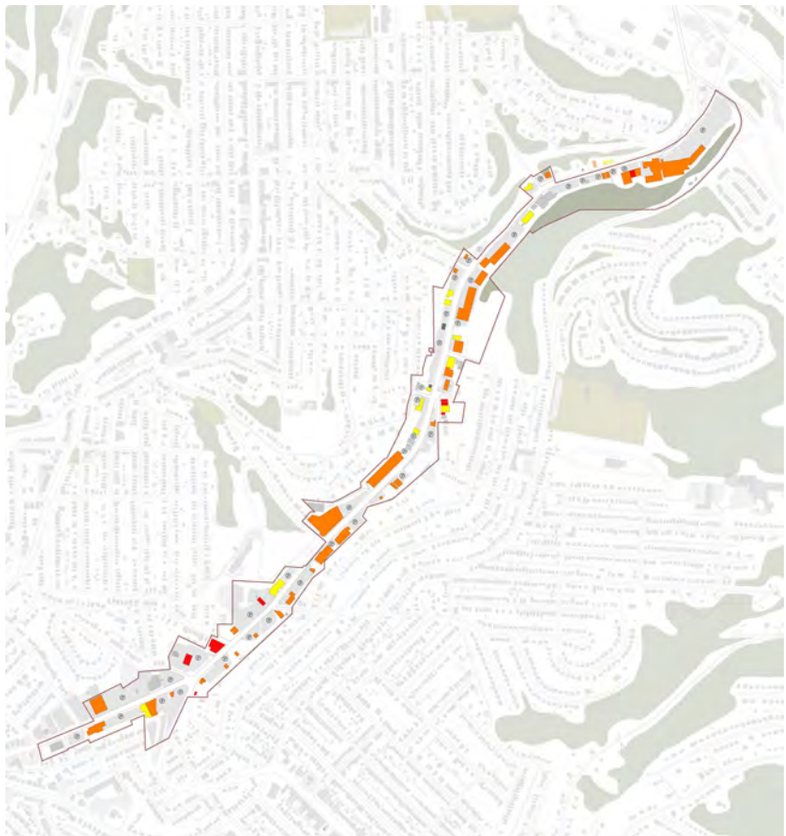
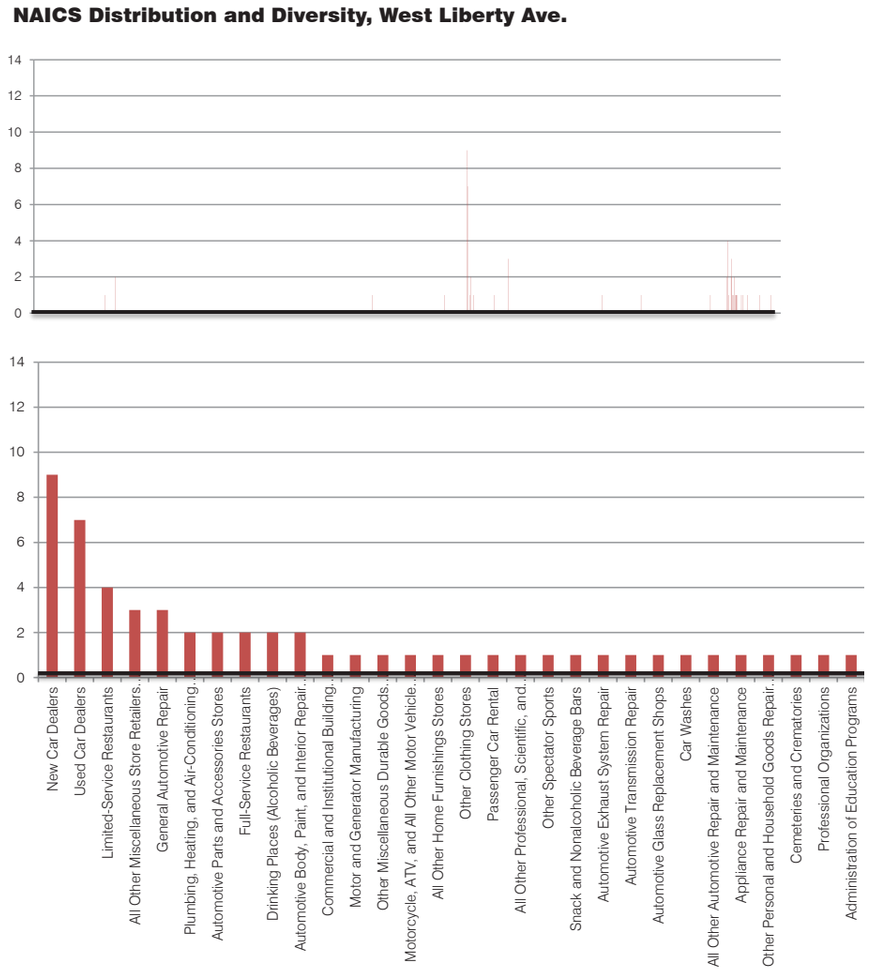


Figure 74: West Liberty Avenue retail types

Key

- Type A: Service
- Type B: General Merchandise
- Type C: Food, Beverage
- Type D: Cultural Entertainment
- Vacant Store Unit
- Non Retail



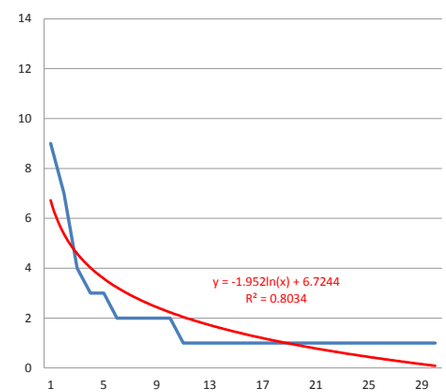


Figure 75 (top): West Liberty Avenue NAICS distribution and diversity

Figure 76 (middle): West Liberty Avenue NAICS dominance sorted by NAICS type

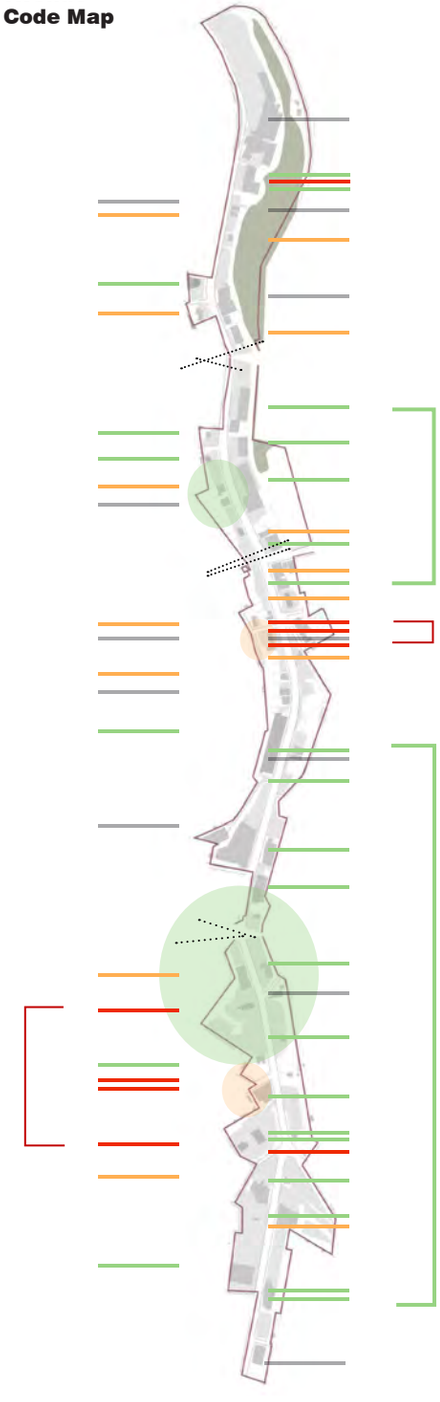
Figure 77 (bottom): West Liberty Avenue patch count distribution

Key

- NAICS 72 Accomodation
- NAICS 81 Other Services (except public administration)
- NAICS 44-45 Retail Trade
- Others

Predominant NAICS Group Concentration

West Liberty Avenue
NAICS Color Code Map



West Liberty Avenue Total	
Total patches	123
Active retail patches	53
Vacant Patches	38
Different unit types	27
Average # units	1.87
Median # units	1
Max number units	9
Pc (A): 0.4308	

Naics of max
441110 New Car Dealers

New Car Dealers and Used Car Dealers are 29% of the total number of units

57% of the total number of units are auto-related (car dealers including repair&service)

16% of the total number of units are food related retails

Figure 78 (top): West Liberty Avenue data set

Figure 79: West Liberty Avenue NAICS color map shows th location of dominant NAICS types

Figure 80 (on page 96-99): West Liberty Avenue street facade

In summary, West Liberty Avenue will never be connected in the way some of the other corridors we studied, but the Pc (A), Pc (O) and Composite Pc 1 suggest that it is more coherent than its image suggests. Its role as foil to measure against and compare and contrast is confirmed. It highlights the need for measurements that do not simply echo a perceptual assessment of connectivity, but evaluate it, particularly as we explore the drivers of connectivity. One possible design conclusion would be to accentuate the location's character as the metropolitan car retail corridor, while improving its walkabilty.

5 6

7 9

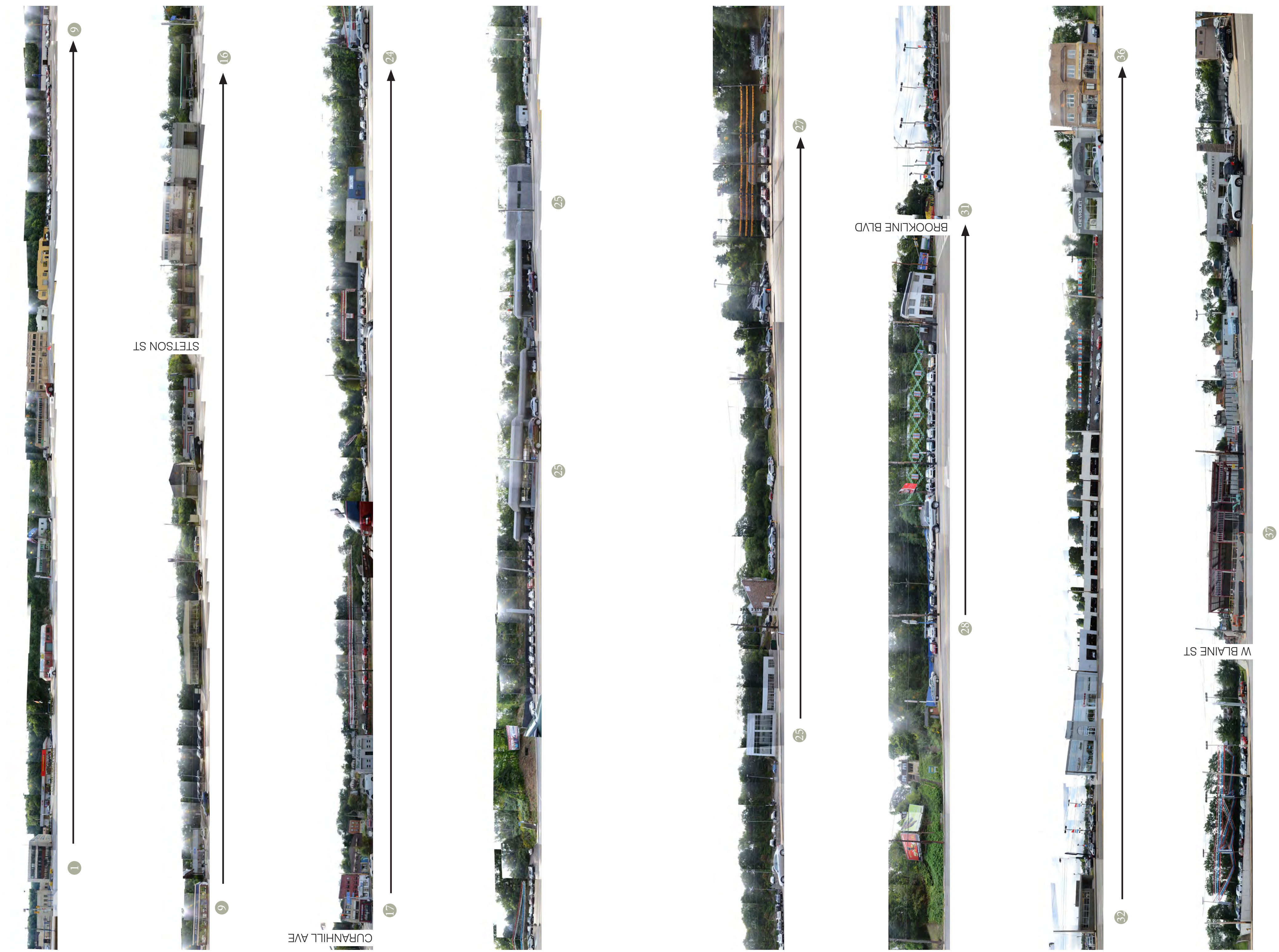
10 13

14

15 16

17 20

21 22


STETSON ST
CURANHILL AVE
BROOKLINE BLVD
W BLAINE ST

4.5 EAST END

Pittsburgh's East End neighborhoods are an amalgam of some of the wealthiest communities in western Pennsylvania, with some of the poorest. It is composed of Oakland and East Liberty as well as a dozen neighborhoods. Long the home of Pittsburgh's upper income citizen, from when Andrew Carnegie and Henry Clay Frick were neighbors and Westinghouse, the Mellon family and the Hunts (Alcoa) lived along 5th Avenue, the East end is today better known as the cultural center of the Pittsburgh region. Andrew Carnegie founded his Carnegie Museum, Library and Music Hall in Oakland in 1895. Carnegie Technical Schools (now Carnegie Mellon University was founded in 1900 and The University of Pittsburgh moved its campus from downtown Pittsburgh to Oakland in 1908. Today the East End is home to 4 colleges and Universities and host approximately 45,000 students during the school year.

While Oakland was always the cultural and educational hub in the east end, East Liberty was its commercial hub. Originally an industrial and railroad hub, it developed into the areas primary shopping areas. At one point, East Liberty was reputed to be the richest suburb in America at the end of the Civil War. But the down side was the poor neighborhood where working class people lived to work in the mills, stockyards and railroad facilities, as well as household help for the wealthy families. The remnants of that dichotomy still exists to in demographic patterns which put high income neighborhoods literally across the street from some of the poorest neighborhoods.

Today within the larger East End, there are several commercial centers or main streets, including Oakland and East Liberty, Walnut Street in Shadyside, Liberty Avenue in Bloomfield, and several smaller neighborhood retail clusters which are not quite main streets. Nearly a third of Pittsburgh's population lives in the East End, and its cultural, educational and burgeoning entrepreneurial culture are all critical to Pittsburgh's economic rebirth.

Figure 81 (page 101): Neighborhoods in East End and main streets highlighted with orange

East End Previous Data Set

Walnut Street

Walnut Street	
Total patches	95
Active Retail Patches	93
Vacant Patches	2
Different unit types	31
Average # units	3.25
Median # units	2
Max number units	12
Pc (A): 0.9789	
Naics of max	
448120 Women's Clothes	

Figure 82: Walnut Street data set

Walnut Street is Pittsburgh's premier shopping street. Some 30 plus years ago it was a neighborhood commercial street made up mostly of neighborhood restaurant and bars. It has grown and evolved over the decades into a high end retail street of national chains such as Apple, Banana Republic, Talbots and the like alongside boutique shops and specialty food/drink/grocery tenants.

As West Liberty Avenue represents the auto-centric retail corridor at one end of the main street continuum, Walnut Street represents the other. It is included in our study to see what the numbers would look like for an ideal connected street. The Neutral Model Pc's show a .9964 for the structure. Walnut Street has no breaks in its street except for very narrow (< 30') cross streets. In our initial studies of the module size, Walnut Street was the benchmark we used.

Key

- Type A: Service
- Type B: General Merchandise
- Type C: Food, Beverage
- Type D: Cultural Entertainment
- Vacant Store Unit
- Non Retail

Figure 83 (below): Walnut Street retail types

Figure 84: Intersection of Walnut and Bellefonte

Findings

The NM Pc's for the 36' and 70' modules were both over 1, indicating that those modules were too large. 24' was the largest module tested that generated a NM Pc < 1 on Walnut Street.
Density is 8.33 units per acre for Walnut Street, highest of the data set except for Broadway 3, which was a single sided, short street with no cross streets. Walnut Street's density is twice that of Downtown Pittsburgh in spite of the fact that the buildings are only 3-4 stories tall at best.

NAICS Distribution and Diversity, Walnut Street

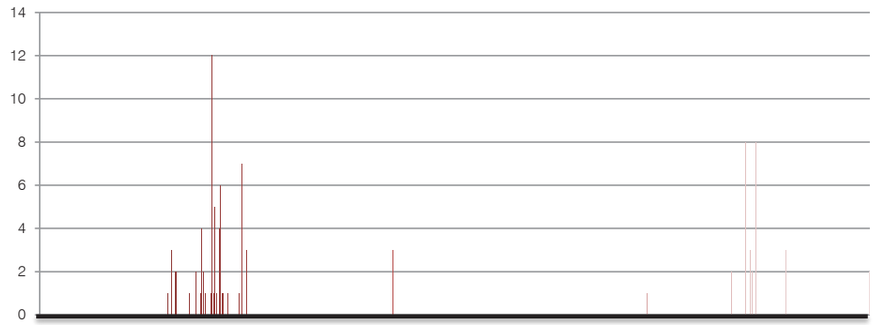


Figure 85: Walnut Street NAICS distribution and diversity

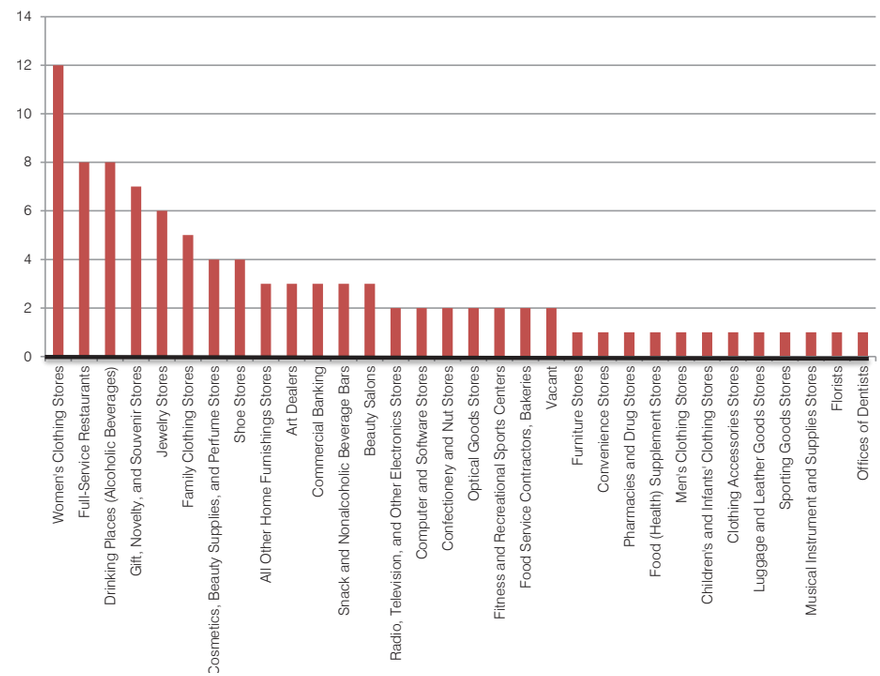


Figure 86: Walnut Street NAICS dominance sorted by NAICS type

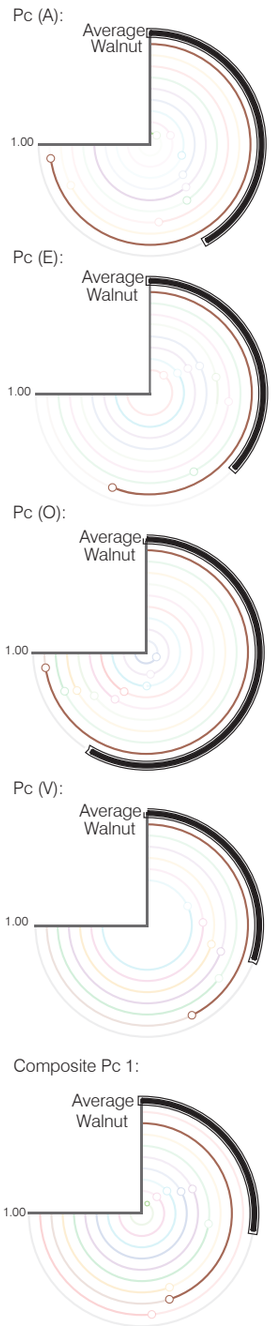


Figure 87: Walnut Street Pc Values

The Dominance factor for Walnut Street is .33, as is its Diversity measure, which is unusual. The NAICS distribution graph (Figure 86) shows two strong clusters – women's clothes and eating and drinking places. This means that there are three roughly equal dominant retail types (women's clothes (12), restaurants (8) and drinking places (8)) uniformly represented along the street, providing a wide range of choices of several different kinds of shopping experiences. The composition of the retail on Walnut Street more closely resembles a mall or life style center than a typical neighborhood main street.

Pc (A) – Active Retail on is .9780, which means that almost every patch on the street is occupied by retail activity.

Pc (E) at .7560 and Pc (V) at .58 reflect strong street walls and a sense of enclosure.

Pc (O) - Fragmentation indicates nearly no fragmentation. There is simply no additional space along the street currently.

Walnut Street represents an interesting condition, because its fragmentation measurement is so strong, there is what appears to be a transformation of this retail corridor into what might become a lattice. There are several locations where the retail turns the corner, extending the connectivity down side streets (See Figure 84 – enlarge intersection of Walnut and Bellefonte). The retail functions have started to extend down Bellefonte Street in both directions. The parking garage to the north of Walnut on Bellefonte is a strong draw generating traffic between Walnut and the garage, but the same growth is occurring south of Walnut.

We see the lattice structure demonstrated fully in East Liberty and Downtown Pittsburgh, but none of the other sites we studied show this occurring. At some point this has to happen to form urban centers, and we may be seeing that occur here.

East Liberty (Penn Avenue)

East Liberty is a lattice rather than a corridor. It is one of two lattice sites in our study group. At one time East Liberty was the commercial center of the east end, back when the likes of Andrew Carnegie, Henry Clay Frick and the Mellon family lived within a 10-15 minute carriage ride of the East Liberty Presbyterian Church (funded by Andrew Mellon and locally known as Mellon's fire escape).

It sits at a juncture of some of the highest and lowest per capita neighborhoods in Western Pennsylvania. Larimer and Garfield are among the poorest neighborhoods in the city, while Shadyside and Point Breeze are among the highest. This divide plays out in the median household income, at $31,913 and percentage of home ownership at .203) the lowest in our survey group.

East Liberty was a victim of mid-20th century urban design thinking. In the 1960s its downtown was pedestrianized, and an urban ring road built to keep car traffic out of the central business district. Large subsidized housing structures were built on the cardinal points where the main streets intersected with the new ring road. East Liberty died from the operation. What we have now is the early effort at resurrection. East Liberty is again an experiment in urban design thinking, this time seeking to locate big box retailers such as Home Depot and Target in urban settings and an urban grid. It is seeing something of a resurgence - though because of, or in spite of the large retail interventions is yet to be decided.

Findings

The Neutral Model Pc show an extremely low .0985, second only to West Liberty Ave at .0674, reflecting the damage done when buildings were torn down for parking lots and suburban typologies. Its survey rank of 6 may well be a result of good press (Google recently moved their Pittsburgh operations to a near-by, converted Nabisco plant setting off a rush of start-ups and entrepreneurial efforts in the immediate area). Recent new retail development has generated

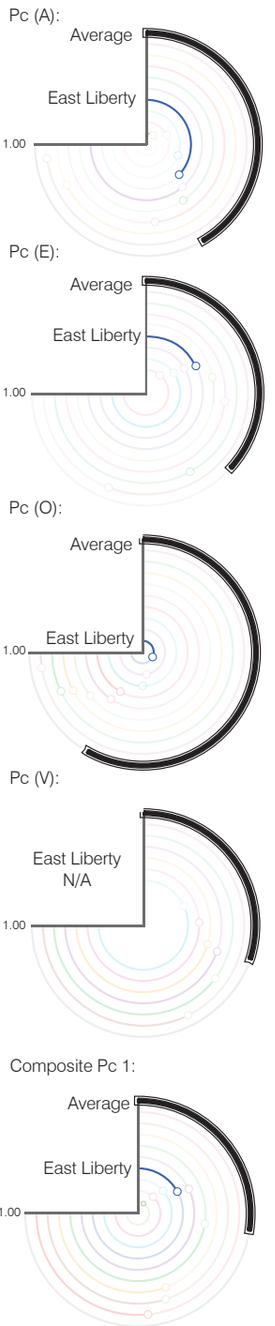


Figure 88: East Liberty Pc Values

a number of new bars and eateries focused on the upper middle income neighborhoods to the south and east mixing with the Goodwill retail store and check cashing frequented by the poorer neighbors to the north and west.

Density is again low – at 1.92 units per acre the lowest in the survey group. Diversity and Dominance factors are strong, suggesting that what retail remains is well used and that the current retail serves an important neighborhood role, as well as becoming a destination for visitors from further out.

Pc (A) – Active Retail tells us that the retail activity is stable, but that numerous storefronts are either empty or being used as non-retail functions that do not contribute to a perception of connectivity.

Key

- Type A: Service
- Type B: General Merchandise
- Type C: Food, Beverage
- Type D: Cultural Entertainment
- Vacant Store Unit
- Non Retail

Figure 89: East Liberty retail types

Pc (E) at .23 reflects the echoes of the damage done in the 1960s.

Pc (O) at .5120 is below average, indicating increased efforts to fill existing space are more important that structural efforts at infill to begin to regain any true semblance of connectivity.

East Liberty is on a long road to recovery. The numbers all suggest that almost anything would help, and nothing will, by itself, solve the problems. Breaking East Liberty down into intersecting corridors and focusing on those selected streets would be the most productive approach. Find the one or two streets that have the highest scores and focus on improving those first. Build from the best intersection found toward the next best intersection until momentum can be achieved.

East Liberty (Penn Avenue)	
Total patches	172
Active retail patches	88
Vacant Patches	84
Different unit types	50
Average # units	3.44
Median # units	1
Max number units	8
Pc (A): 0.5116	
Naics of max: 722211 Limited Service Restaurants	

Figure 90: East Liberty data set

NAICS Distribution and Diversity, East Liberty

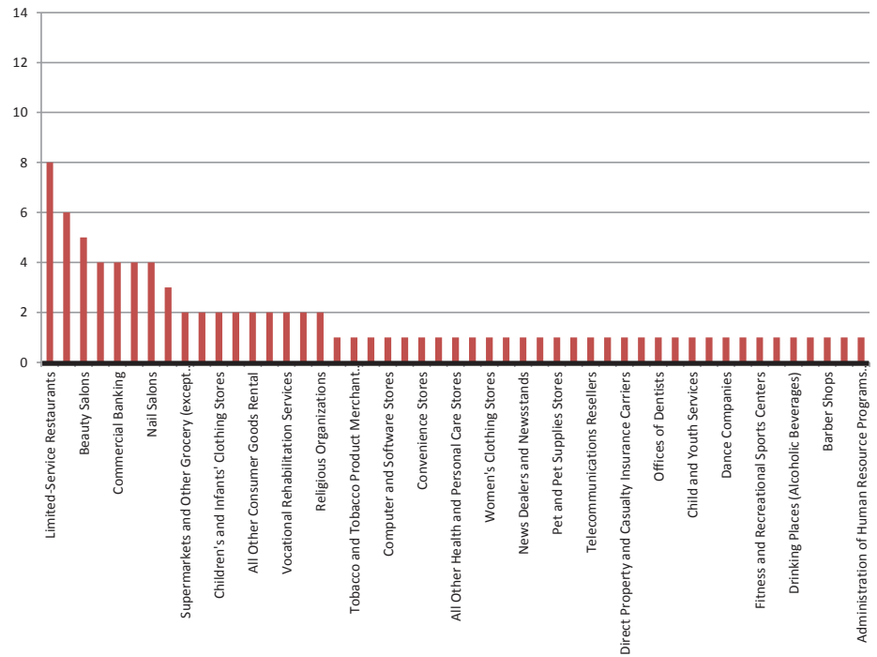


Figure 91: East Liberty NAICS dominance sorted by NAICS type

NAICS Distribution and Diversity, East Liberty

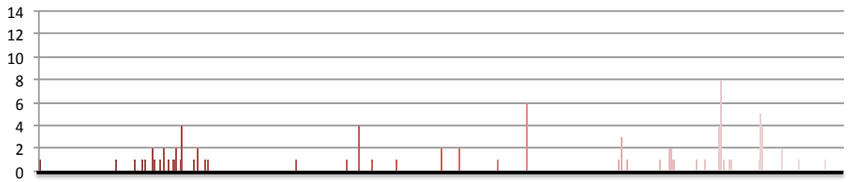


Figure 92: East Liberty NAICS Distribution and Diversity

Figure 93: Liberty Avenue retail types

Key

- Type A: Service
- Type B: General Merchandise
- Type C: Food, Beverage
- Type D: Cultural Entertainment
- Vacant Store Unit
- Non Retail

Liberty Avenue

Liberty Avenue in Bloomfield is Pittsburgh's "Little Italy", a neighborhood of lower middle class people and students from the universities. Its population is slightly higher than Brookline but its average income is roughly two thirds that of Brookline. Liberty Avenue is a main arterial road running through the East End. It is generally not, however, a high speed road, rather a two to three lane street connecting various communities.

There is a distinct difference between the character of the north end of the street and the south end. The north end is composed largely of smaller retailers that could be characterized as neighborhood retail. From about the mid point in the street where the hospital is, the southern end of Liberty Avenue is composed principally of larger structures, parking lots and buildings pulled back from the 'build to' line.

Liberty Avenue	
Total patches	121
Active retail patches	110
Vacant patches	11
Different unit types	49
Average # units	2.47
Median # units	2
Max number units	14
Pc (A): 0.9091	
Naics of max: 722211 Limited Service Restaurants	

Figure 94: Liberty Avenue data set

NAICS Distribution and Diversity, Liberty Ave.

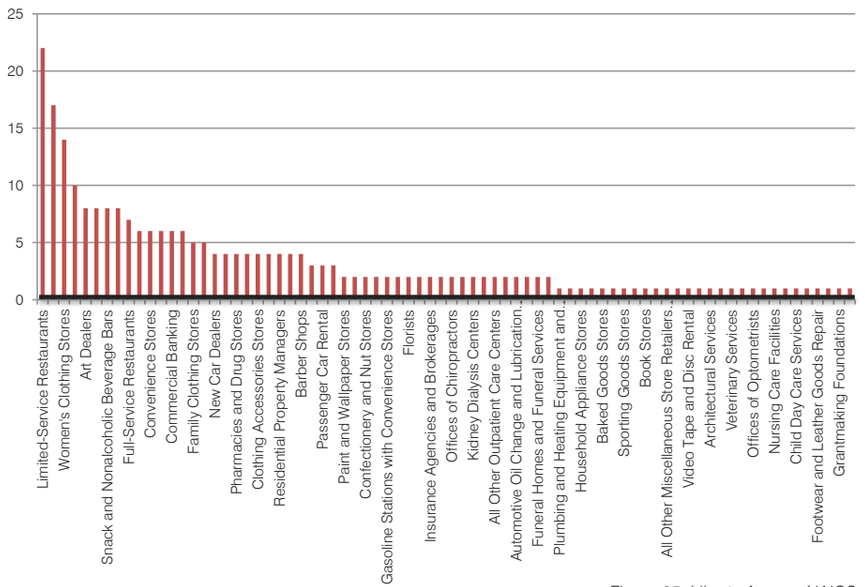


Figure 95: Liberty Avenue NAICS dominance sorted by NAICS type

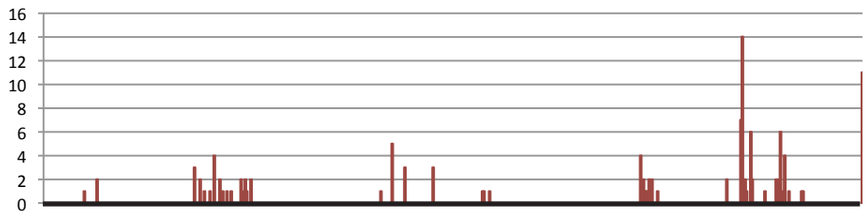


Figure 96: Liberty Avenue NAICS Distribution and Diversity

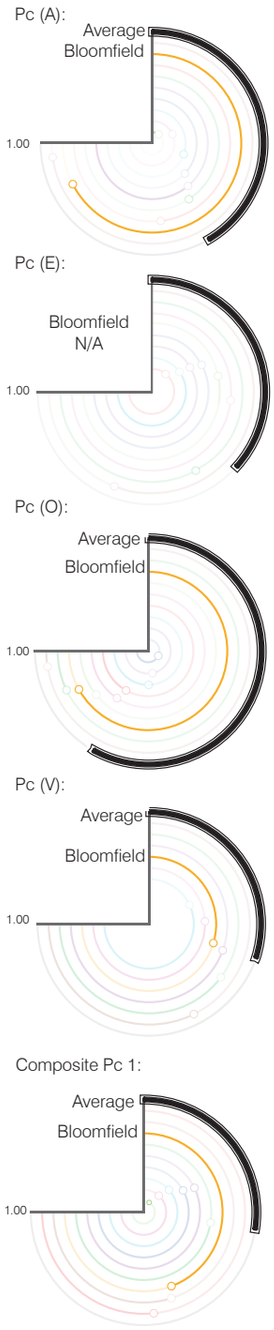


Figure 97: Bloomfield Pc Values

The Neutral Model Pc of .3124 shows a less well-connected street than some of the other metrics would suggest. This is the result of large parking lots and some buildings pulled back from the sidewalk such as gas stations and some auto showrooms along the street. If we subdivided the street into a north a south sub grouping, much higher numbers would result for the north end of Bloomfield than from the south end.

Density is about half the average for all our study sites at 2.78 units/acre, only slightly better than West Liberty Avenue (which is also occupied, to an even larger extent, by big floor-plate structures). Diversity was .445 in Bloomfield and the Dominance factor is .4 – highest in the data set reflecting the strong food focus along the north end of the street, and its reputation as "Little Italy."

Pc (A) – Active Retail on Liberty Avenue is .9091 in Bloomfield, second highest in the study, consistent with its number two place in the survey ranking.

Pc (E) at .3670 and Pc (V) at .41 reflect the impact that the hospital and auto showrooms have on the numbers.

Pc (O) - Fragmentation at .9090 indicates limited vacancies, showing a health commercial corridor. Again, most of the vacancies are at the southern end of the street.

Liberty Avenue in Bloomfield is a tale of two streets. The northern end is a strong healthy neighborhood retail corridor, while the south end of the street is a disconnected collection of large floor plate structures which disrupt the connectivity. The composite Pc 1 shows considerable strength at .6020, second to only Walnut Street. Other indices show a more varied story. The survey rank is probably a result of the north end of the street, as this is also where the restaurants and shops are that most people frequent. If some of the parking lots and gas stations were replaced with more typical commercial typologies at the build to line the street would easily connect throughout its entire length.

4.6 DOWNTOWN

Downtown Pittsburgh is the heart of Western Pennsylvania. Because of its rivers and topography, it was never encircled by the ring road interstate system surrounding many American cities, and the main roads through the area all still converge on the city's central business district. Downtown Pittsburgh alone has approximately 140,000 people working there each day, but only about 2,500 residents according to the 2010 census. From a retail perspective, retail is focused on serving the office market, and they rolled up the sidewalks about 6 pm. That is changing now as residential construction is on the rise and downtown is becoming a more diverse, 24 hr urban environment.

Findings

The Neutral Model Pc of .1410 highlights one of the differences between a corridor and a lattice structure. Comparing this to East Liberty - the only other lattice structure in our study, is useful. East Liberty's NM Pc is .0985, so downtown's NM Pc is almost twice that of East Liberty. On the other hand, Bloomfield (at 8 on the survey rank, just ahead of downtown at 7), has a NM Pc of .3124, and Walnut Street at the top at 9, has an NM Pc of .9964. Understanding the structural implications of this difference is an important future focus.

Density in downtown Pittsburgh is 4.67 units/acre, which reflects the smaller size of most retailers and the higher number of cross streets, parks and plazas in an urban center. Diversity was .298, close to Walnut Street at .333.

Pc (A) – Active Retail for downtown Pittsburgh is .6548, 3rd highest and consistent with the survey rank.

Pc (E) and Pc (V) were not calculated for Downtown because of the difficulty reconciling the lattice verses corridor structure and its impact on the methodology of accounting for the differences, particularly voids.

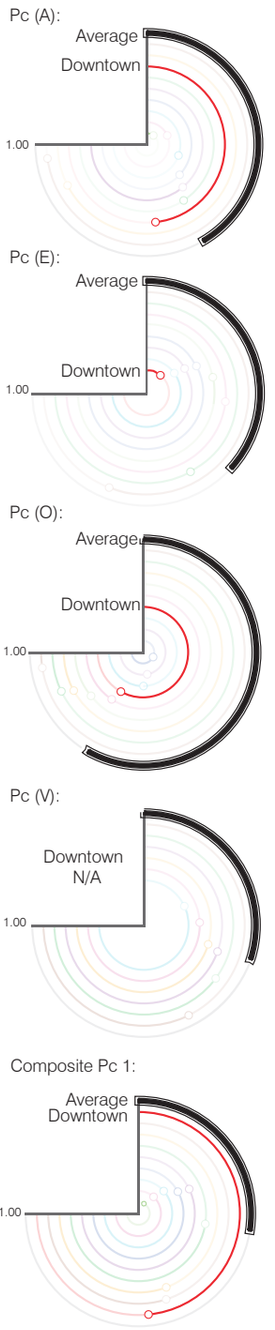


Figure 98: Downtown Pc Values

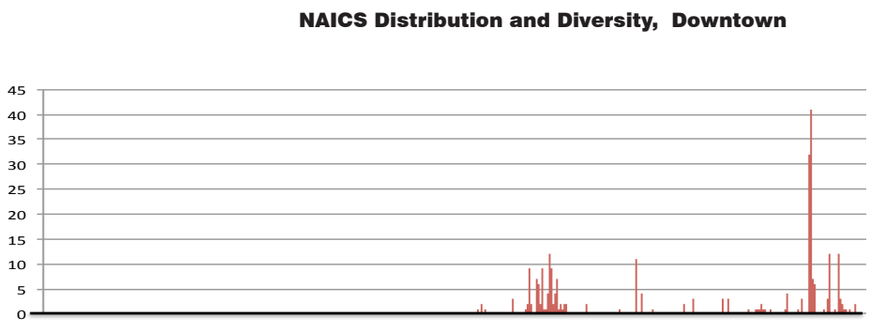


Figure 99: Downtown NAICS distribution and diversity

Pc (O) - Fragmentation Pc is .8020 indicates a healthy downtown retail environment.

Downtown Pittsburgh and East Liberty highlight some of the affects resulting from the transition from a corridor structure typical of most retail main streets, and the lattice structure found in urban cores. Those indicators that are structure related, such as Pc (E) and Pc (V) and density are strongly affected by nature of the lattice structure. Other qualities such as diversity, active retail, and the larger scoped metrics like population, home ownership and median income are not affected.

Downtown's fragmentation rate and active retail is strong, and the diversity and dominance metrics tell us that there is a good mix of retail.

chapter

5

CONCLUSION

5.1 CONCLUSION

We are confident that Percolation Theory and its application to urban conditions has merit. The results to date show promise in assessing both the physical/matrix and the perceptual components that make up connectivity. Additional data is required to make the correlations and conclusions more broad-based and less volatile, but we feel this is a viable and valuable line of research. Characteristics, measurements and metrics can be refined and tailored to deliver higher fidelity predictive power based on more data and further analysis.

The choice of a 3-neighbor rule verses a 5-neighbor rule is probably the next important step in this study. The neighborhood rule selection is dependant on the biological functions at work (or under study). As such, in this study we have assessed both 3 and 5 neighbor configurations against structural and perceptual benchmarks and vise versa in an effort to sort which elements are significant. We have identified several, including the Voids analysis - Pc (V) and Street Edges - Pc (E) that are particularly affected by neighborhood selection. That choice defines the active edge depth (Figures 19, 20 and 21). Understanding why the factors identified here have the affects they do (why do voids in street-walls affect the perception of connectivity? Does transparency make a difference, and if so, why?) is a critical next step. We see in our correlation analysis a strong positive correlation in all three benchmarks (Survey Rank, NM Pc, and Pc (A)) between these metrics and the void and street face edge. This suggests that a 5-neighbor rule may be a more accurate reflection of the biological functions driving that pattern. Our research project has just started to explore a methodology for identifying and testing those ideas. A larger team of diverse experts will be required.

Future work that combined a team of Environmental Behavior/Neuroscience experts, our work in Urban Ecology, and experts in Cellular Automata and agent based modeling could take this concept to a truly valuable level. Refining and expanding on our work here will identify other qualities and characteristics that should be included (or excluded) for the assessment. Cellular automata modeling could be built on the rules developed from an EB/Neuroscience effort, and the relationships identified in further Urban Ecology research to create predictive models which would allow public official, architects and their teams, developers and retailers all to better understand the implications of their opportunities and decisions. Ultimately a composite Pc can be developed that reflects the drivers unique to human perceptions of connectivity on main street. That understanding would allow us to make more sustainable, long-term decisions on how we build and manage our urban ecosystems.

Imagine this scenario, sometime in the future:

The Director of the Urban Redevelopment Authority has been asked by the mayor to identify opportunities to invest in community main streets within the city. As is normally the case, money is tight, so the mayor has allocated $250,000 for investments in targeted areas where the communities will benefit significantly.

The director has his staff update their data on all the communities that might fit the criteria, including a percolation analysis of the commercial corridors. In looking at the data, he sees that four of the commercial districts are already above the Pc and are ‘connected’. They have reached a state of self supporting connectivity, and additional governmental support is not warranted. There are 5 other main streets that are below the Pc. Should he invest in those with the lowest Pc to try and bring them up, or in the highest non-percolating areas to push them into the ‘connected’ category? He decides to invest in those near the tipping point with the objective of getting them to a connected phase. His rationale is that stronger main streets will generate both more tax revenues and build a stronger sense of community in those areas. The additional revenues can then be used in part to build up the other areas of the city.

He calls the local community development manager/main street manager for the two communities targeted. He explains to her the good news about the investment as well as his rationale and expectations for the task. She asks for the data behind the analysis as well as details on schedule, funding process and such. She realizes early on that the money will not be enough to completely rebuild or even significantly intervene in the main streets without outside support. She identifies two tasks which she needs to accomplish: she needs a study done of the target areas by an architect who has a solid understanding of how main streets work and understands the data the percolation analysis represents. She also needs to meet with local business and development people to build broader financial support in order to achieve the directors' goals.

She hires an architectural firm who is familiar with percolation theory as it applies to urban places and who has experience in successful community level urban design projects. They meet initially and review the data supplied by the URA director, and discuss options. One of the partners points out that the two identified sites have exceptionally low scores in the NM Pc 24 category, suggesting that there are some significant structural issues that might be opportunities to address with significant payback. Since NM Pc 24 is strongly influenced by density and voids % (see Correlation Analysis), one avenue for consideration are ways it improve those scores. In fact, one area has a void percentage of 74%, suggesting opportunities to infill in targeted areas to begin improving the structural connectivity. This area has very high-density numbers, but the team senses that something is not right with those numbers. They decide a site visit to both areas is in order.

In the site visit they determine that the reason to density is so high is that the retail is only on one side of the street, resulting is high density but limited total Pc composite. They also see that the Pc (O) is very low meaning that there is a lot of vacant space available. This might be an opportunity for some business development efforts rather than bricks and mortar. The team breaks after the site visit so the design team can drill down into the numbers and begin to assess the opportunities and challenges.

During a more in-depth analysis, the design team decides to do Pc calculations at a block level to get down to a scale where they can make specific recommendations. They note that the Pcs for each block vary significantly, helping them to narrow their focus. They also do detailed calculations of components of the Percolation Coefficient to identify what specific issues they can, and cannot, address in their scope of work. Breaking out storefront transparency, they identify an opportunity to implement a façade improvement program in one of the communities which would assist owners to increase the amount of glass in their facades among other options.

Meanwhile the community development manager arranges meetings with the local business community including retailers and developers who focus on smaller community infill projects as well as other business representatives active in the community. She presents the data from the percolation analysis and the recommendation from the design team, then she explains in broad strokes the highlights of the study. She highlights the targeted nature of the undertaking and the research that has gone into developing this tool.

The fact that there is a rationale behind the decisions and direction are well received by the group. They admit to a preconception that these kind of projects are done to satisfy some politically connected interest, or are 'pork barrel' projects with no basis in reality and no hope of success. They see that this approach, based on a clear, quantifiable understanding of how main streets work can be a cost-effective approach to rebuilding their community. The design team's findings, recommendations and urban design master plan as well as specific development proposal can be judged against the data rather than just assessed as a "pretty picture."

Public presentations by the selected developers and their design teams were assessed by the city's URA

against the original data and discussions of the proposals were held based on how well the proposals met those requirements allowing all parties to understand and respond to the design and development proposals with a common metric.

5.2 FUTURE STEPS

Pedestrian Vision Study

How far do we see? How much time, on average, does an object keep our attention as we walk down a main street? These are two questions that help us to start mapping a person's possible vision cone as she/he walks down Brookline Boulevard from Pioneer Avenue to Castlegate Avenue. Buildings facades are important as they create physical edges that orchestrate people's movement along a path. Therefore, their location and their relationship to the sidewalk is crucial. The amount a building is setting back from the property line changes our perception as well as our attention as we walk. The dark areas on the diagram where building facades are very

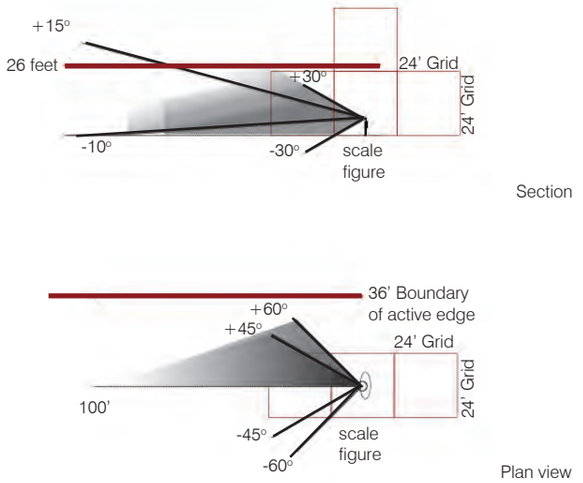


Figure 100: Detailed legend that is taken into consideration when Figure 101 is being created. It shows limits of vision cone.

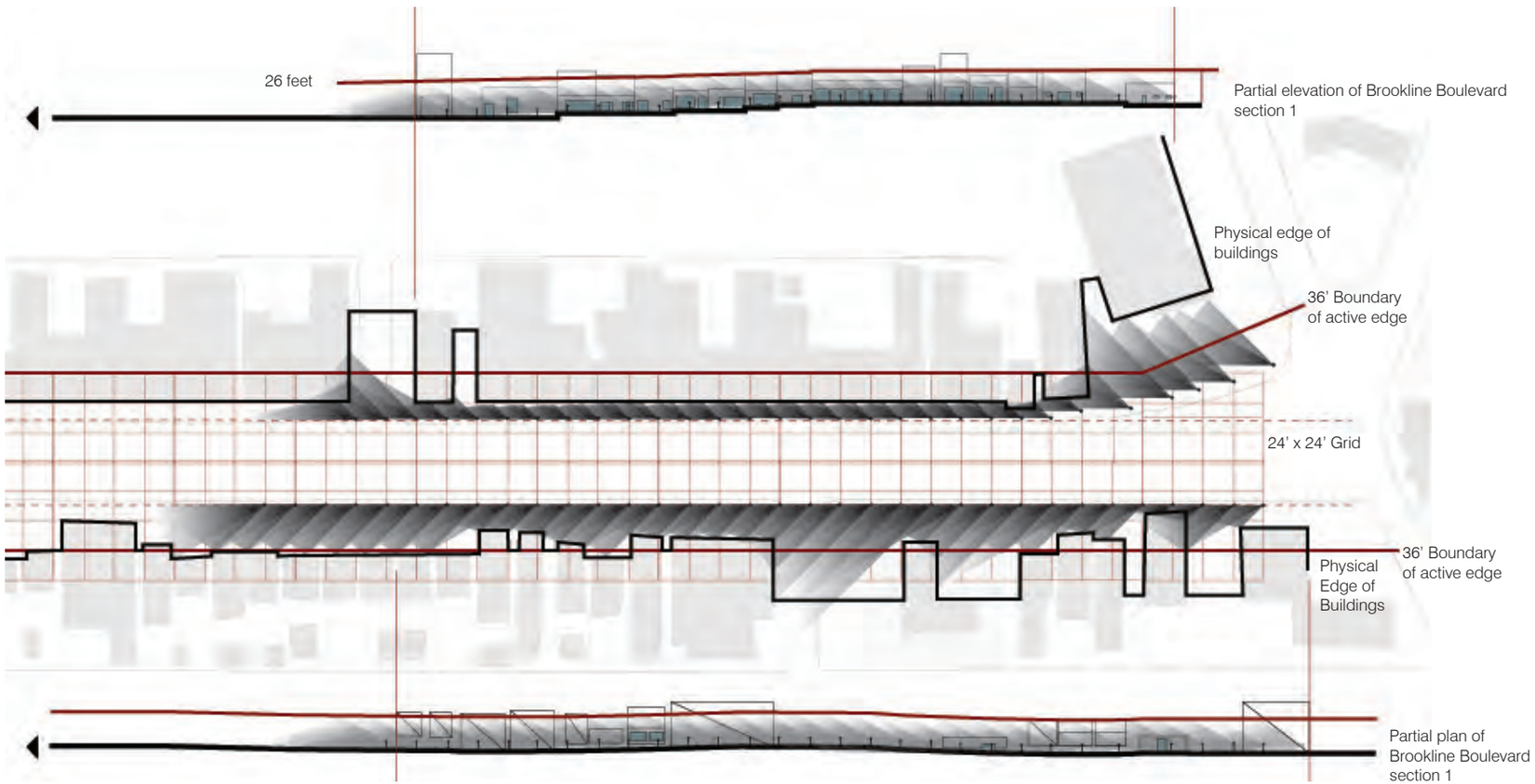
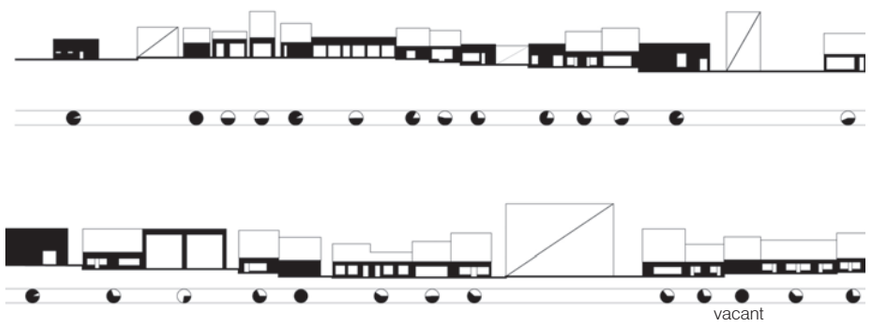


Figure 101: Pedestrian vision study diagram shows possible vision cone of a person walking from north west to south east of Bookline Boulevard section 1.

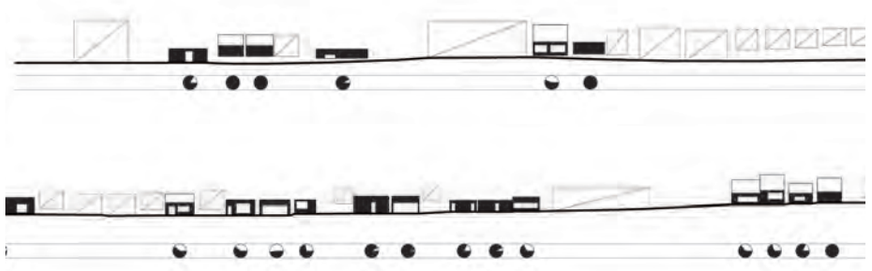
close to the sidewalk represent the possible zones where people's attention might be maintained.

The pedestrian vision study is believed to be strongly related to Pc (E), Pc (V) concepts introduced in Chapter 3 as well as transparency study introduced on the following page. As this study moves forward, the diagram shown in Figure 101 could be applied to other main streets in order to study different patterns of "attention zones." Pedestrian movements could also be mapped on-site and juxtaposed with pedestrian vision study maps in order to see if people's recorded movement corresponds with the previously identified dark/attention zones.

Brookline Boulevard Heavily Commercialized Side of the Street



Brookline Boulevard Mostly Residential Side of the Street



Transparency Study

The impact of transparency on a retail corridor's connectivity is an important but not fully explored issue in this study. We believe that glazed areas or perforated surfaces that allow people to see into stores may be an important determinant in affecting movement of people walking through main street.

Transparency adds depth to a street facade that expands the boundary of 36' active edge. It creates a zone where retail products or activities are displayed for people's attraction. It may change a pedestrian's direction, how much time she/he spends on a retail corridor and what sort of visual memory she/he have to cause them to return.

Figure 103 shows a first attempt to understand this criteria. Brookline Boulevard is chosen as a test location by looking at the percentage of solid versus void (or glazed) area. For this quick study, a simpli-

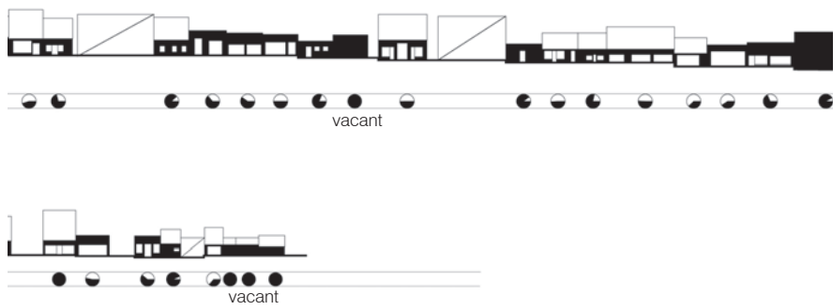
The transparency rate of ground floor retail store units on hevaily commercialized side of the street is 34%. (34 sqft is transparent per 100 sqft of wall)

The transparency rate of ground floor retail store units on mostly residential side of the street is 25.8%. (25.8 sqft is transparent per 100 sqft of wall)

Figure 102: Transparent area out of total facade area of ground floor retail stores.

Key

- Solid wall areas on ground floor
- Transparent (glass) areas
- Non-retail buildings



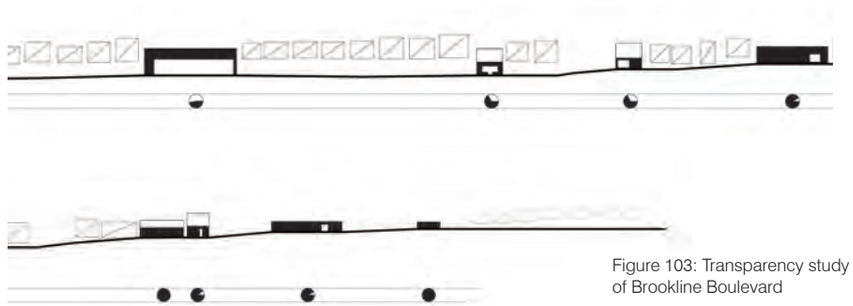


Figure 103: Transparency study of Brookline Boulevard

fied facade is traced over the street elevation field photography and glazed vs. wall areas are identified and calculated.

The study considers only the ground floor condition since this is the direct zone of interaction with people on the street. Non-retail buildings were not included and vacant retail stores were calculated as solid areas since the views in did not display anything that would cause passerby to stop or shop, even if they are glazed.

With the case of Brookline Boulevard, its interesting one-side corridor is registered in this quick study of transparency. Calculations show that transparency rate is 34% on the retail side of the street whereas it is 25.8% on mostly residential part of the street. Similar analyses should be done for other the main streets to compare transparency rates and to see if and how these numbers correlate with other aspects of the study.

chapter 6

REFERENCE

6.1 Urban Lab Syllabus

The Urban Lab studio at Carnegie Mellon seeks to educate architects to be leaders for vision-based change at the scales of neighborhood, city and region. The chosen approach to urban design engages the city as an integrated design problem that is best solved through a participatory design process. Each year, teams of students and faculty seek to catalyze the revitalization of Pittsburgh urban neighborhoods by working with elected officials, public agencies, private investors, and citizens of communities to collectively envision physical change within their neighborhoods and communities.

In the fall of 2012, the Urban Lab studio examined the South Hills neighborhoods of Beechview and Brookline to coincide with this research project on the ecology of retail corridors. While the studio was not focussed solely on the study or design of retail corridors, there were definite areas of overlap amongst the two efforts, in part due to the studio schedule. Divided into three unequal phases, the Urban Lab dedicates the first third to documentation and analysis, the second to an urban design framework, and the third to areas of focus. Each phase is punctuated by public meetings with stakeholders and community groups so that the students are able to present their work and receive critical feedback from those with firsthand knowledge of the neighborhood. Phases one and two are conducted in very large teams, allowing data to be collected and sorted quickly, and an overall vision for the neighborhoods to be formed in a short period of time. The studio group then break into smaller teams of two to conduct the area of focus design in the final third of the semester. The data and analysis compiled in phase one was of great help to the research team. Conversely, the research team's findings were brought to bear on some of the design work created in phase three, particularly those that addressed retail along a main street.

What follows in this chapter are three projects from the fall 2012 studio. Figure 105 and 106 are the two examples of the excellent effort of the framework group that demonstrates their desire to better connect the main streets of Beechview and Brookline (Broadway Avenue and Brookline Boulevard respectively) to each other and to the city through improved street section design and through the creation of transit-oriented mixed use at each end of the corridor. This work is followed by two areas of focus, one at the north end of Broadway, and the other at the south end of Brookline. Both projects benefit from the research team's findings, and both would contribute greatly to the overall connectivity of these neighborhood main streets.

The Urban Lab

PROJECT FLOWCHART

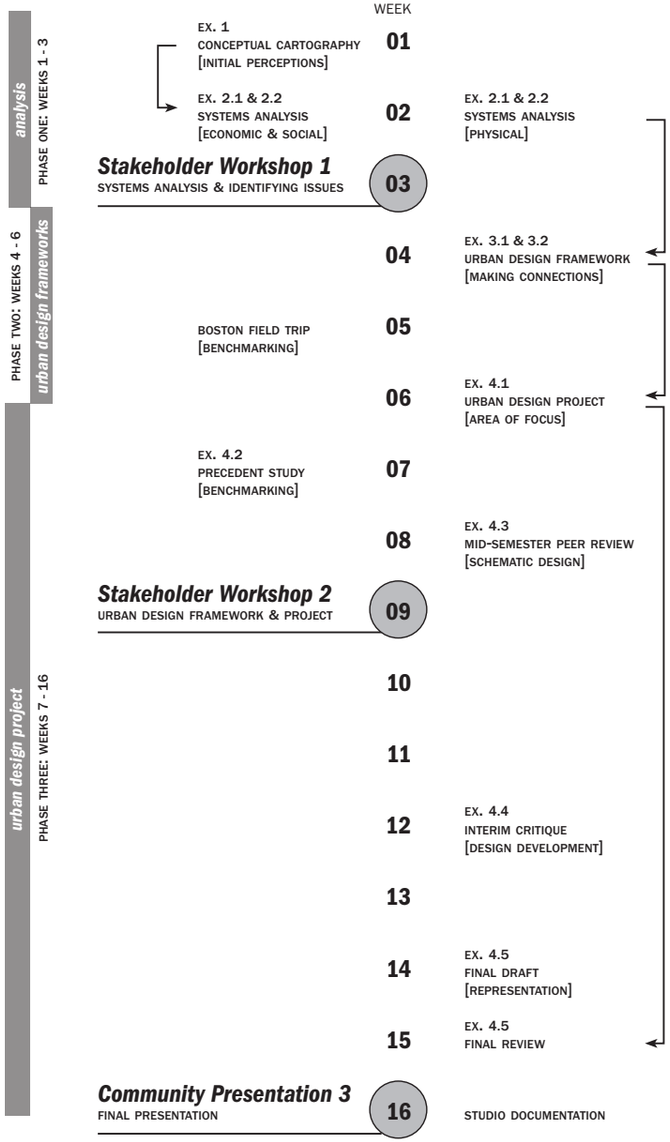
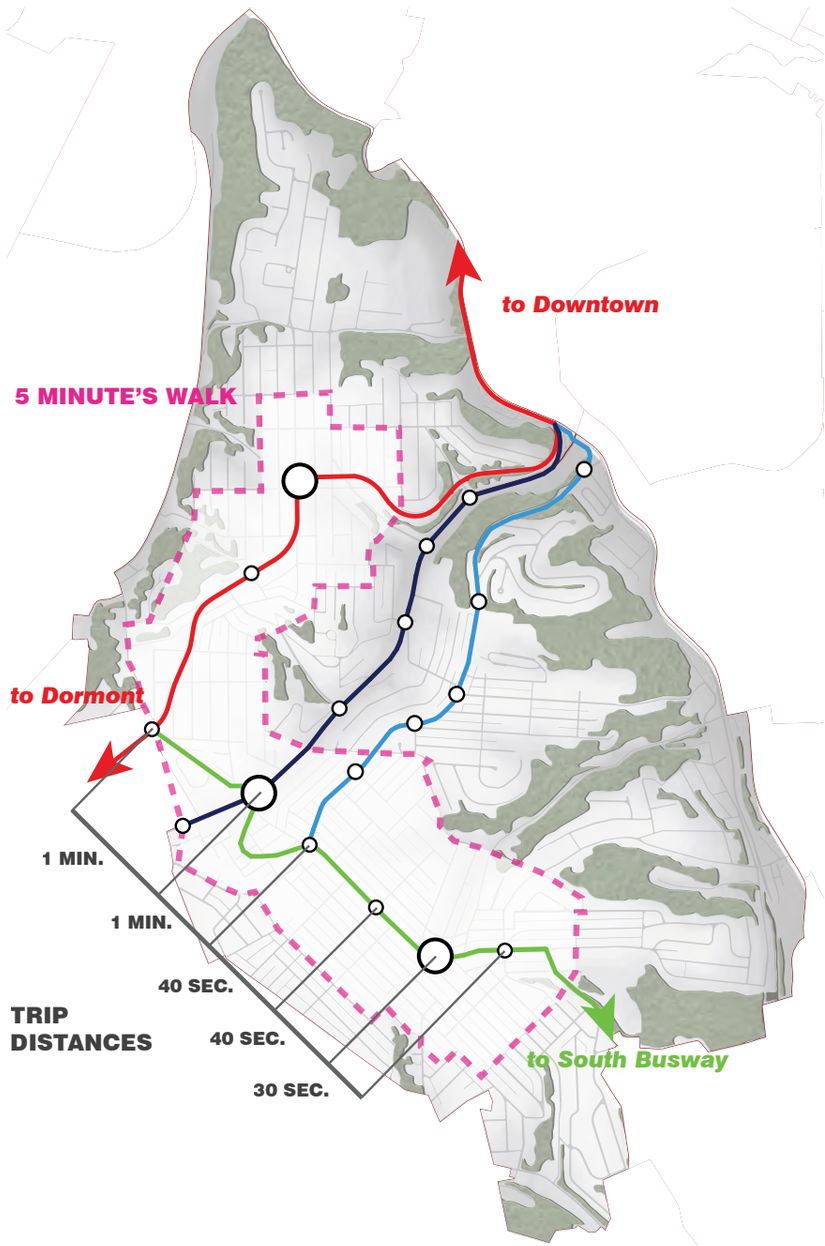


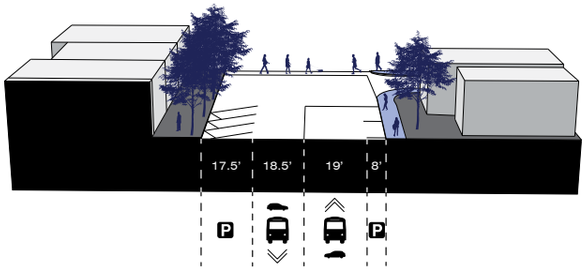
Figure 104: Schedule of the Urban Lab Studio

6.2 Urban Lab Student Work

Figure 105: Urban Lab 2012 framework proposal as it relates to improved transit. It shows TOD adjusted travel time.



Existing Brookline Section



Redesigned Brookline Section

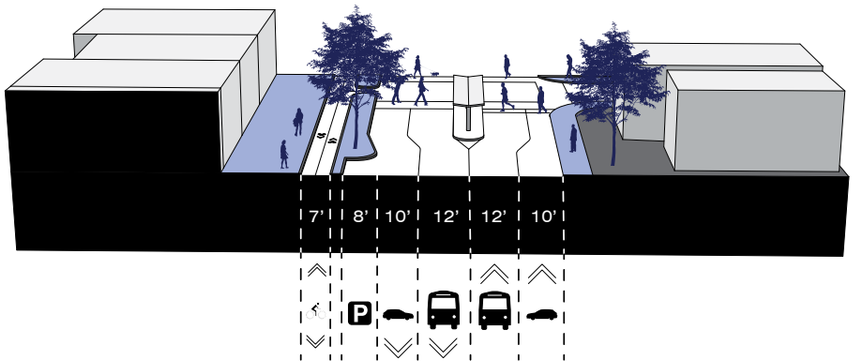


Figure 106: The framework also proposed redesign of the street sections along the retail corridors including Brookline Boulevard.

Canon Plaza & Apartments

Joe Chang & John Soh

While the north end of Brookline Boulevard is seeing increased activity and new businesses, the southern end does not show such signs of revival. The southern end of Brookline Boulevard is marked by the Brookline Cannon Park, which also serves as a veteran's memorial. There are commercial stores surrounding the park but the occupancy rates of these stores are extremely low. Coupled with this, the high traffic volume and the speed, the Cannon Park stands as an isolated island with little pedestrian traffic. The new plaza and apartment at the heart of this proposal hope to remedy this situation.

The project plans to create a new plaza and building to increase activity on the southern end of Brookline Boulevard. Based on current demographics statistics, we can see that there will be an increase in the senior population around Brookline. The current senior home nearby will not meet the demands of the new, more active group of retiring seniors. Therefore, this proposal plans to create a three story senior apartments with community center and retail on eleven parcels to the south of the plaza.

Figure 107: A perspective showing the new plaza and apartment building at the southern end of Brookline Boulevard.

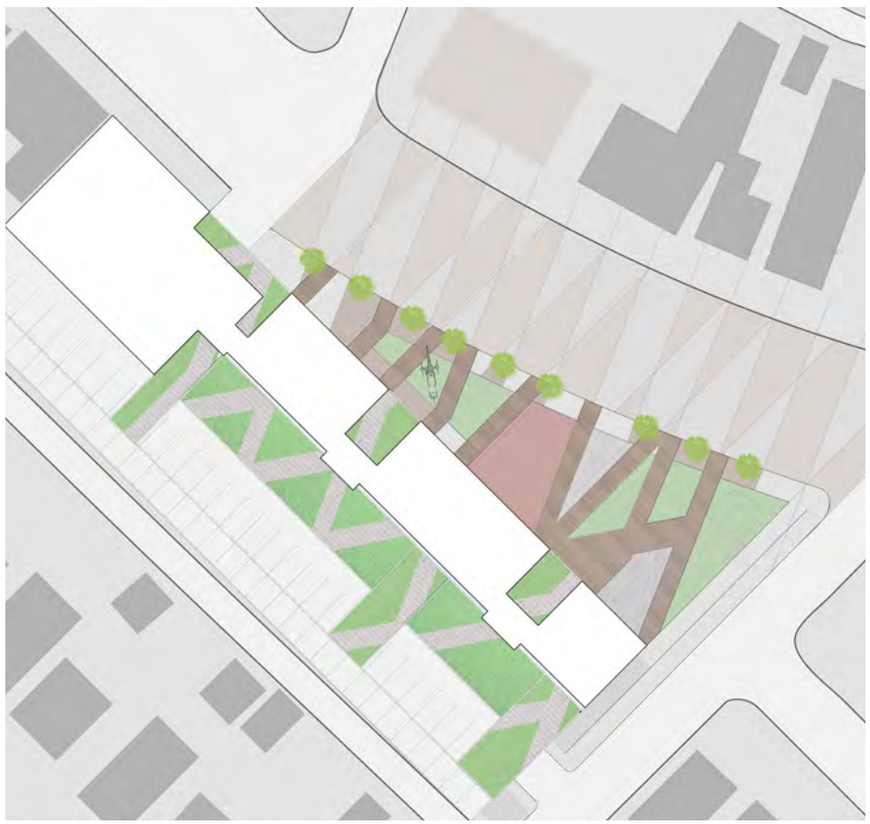


Figure 108: Context and site plans showing the location and design of the new plaza, which is now directly accessible from the street sidewalk. Elevation and perspective demonstrate the increased and improved retail at ground level with housing above.

Fallowfield Square

Sarah Harkins & Thomas Groner

This project is a response to the conditions that currently characterize Broadway Avenue and the commercial center of Beechview. Issues such as vacancy, poor quality housing stock, and under-utilization of the light rail have blighted the core of this community. This project is rooted in a vision of a redeveloped town center that provides greater economic and housing opportunities, bolstered by the rapid transit link to the heart of downtown Pittsburgh.

This proposal celebrates the T as the most significant asset in Beechview. The T is an infrastructural resource that is unique to the South Hills, provides a fast and easy connection to the city, and has the potential to bring life and activity back to Beechview's commercial corridor. Various other transit oriented developments around the country have showcased the success that these types of projects can achieve in attracting new residents, businesses, and vibrancy. In this way, Beechview has the potential to become Pittsburgh's next thriving, transit-oriented neighborhood that enjoys benefits of both the city and suburbia.

At the core of this project is a grand square designed to serve as the hub of a newly invigorated community. Large open spaces provide resources for local events and promote the role of the pedestrian in day-to-day life. A relocated transit stop helps to shift the pedestrian flow into the square, while the T periodically cuts through the plaza at grade, acting as a dynamic presence and further mingling different forms of transportation. Seven new buildings provide a new residential units and retail and office space, all of which is connected by the square that serves as Beechview's new public living room.

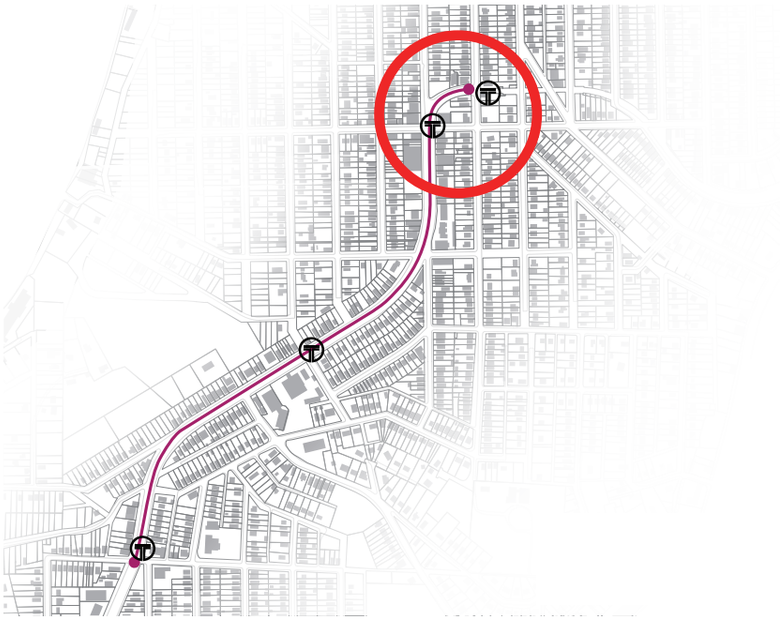


Figure 109: Context plans showing the location of new square and aerial perspective showing its character.

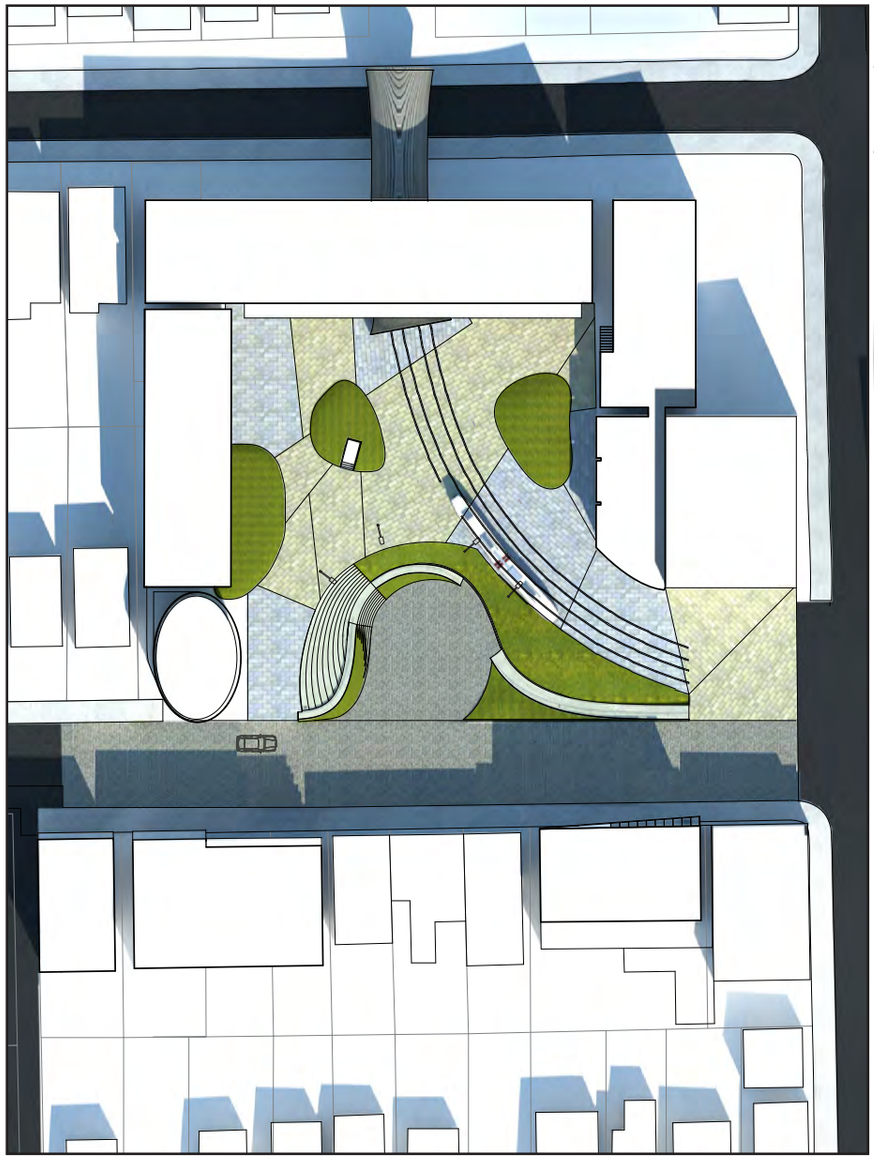
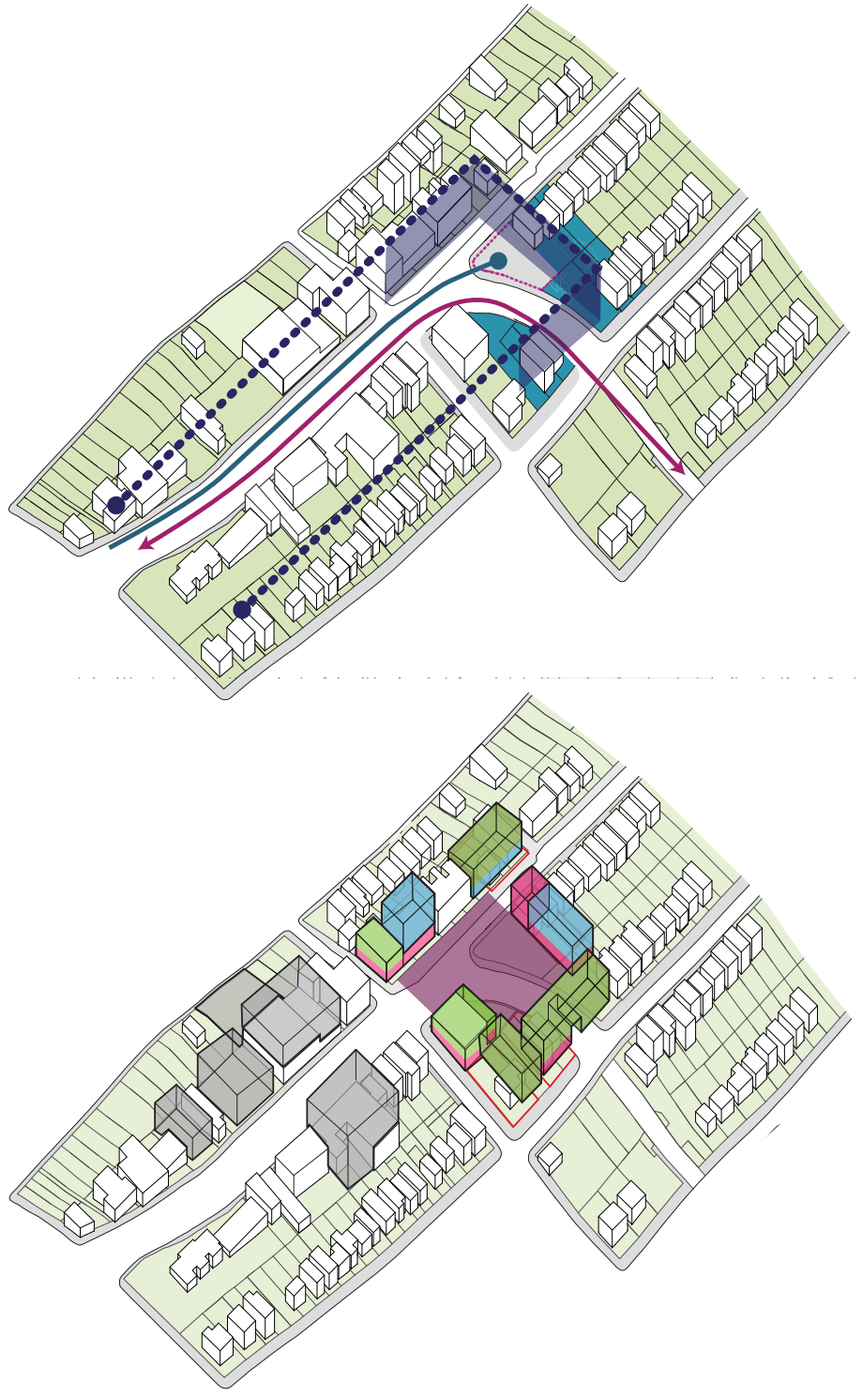
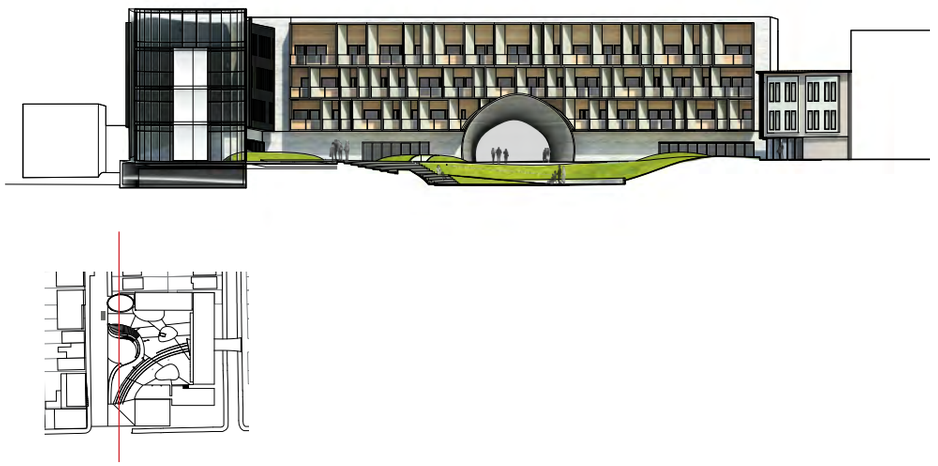


Figure 110: Site plan of Fallowfield Square. The axonometric drawings reveal the potential impact created by the insertion of a few new buildings and a plaza.





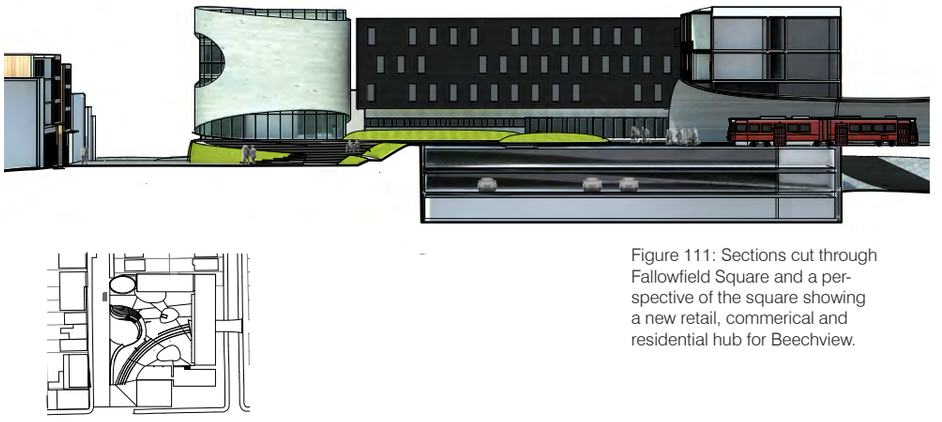


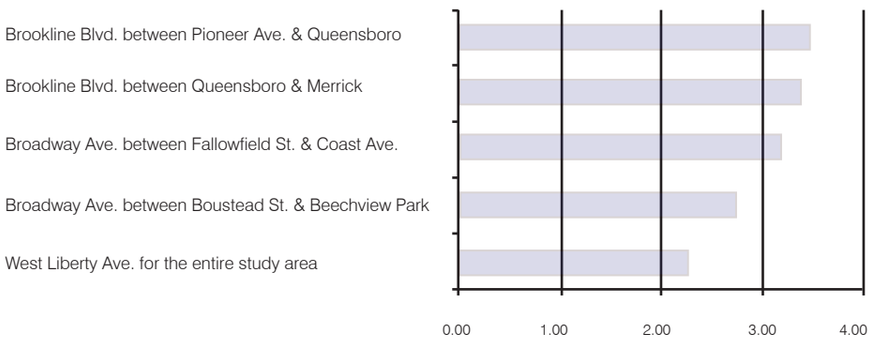
Figure 111: Sections cut through Fallowfield Square and a perspective of the square showing a new retail, commerical and residential hub for Beechview.

6.3 Survey Results

Question 1: Based on your involvement in the Fall Semester Urban Lab project, rank the following main street segments based on your perception of their connectivity. Use 1 as the least connected and 5 as the most connected.

Answer Options	1	2	3	4	5	Rating Average	Response Count
West Liberty Ave. for the entire study area	6	1	1	1	2	2.27	11
Broadway Ave. between Boustead St. & Beechview Park	3	2	1	5	0	2.730	11
Broadway Ave. between Fallowfield St. & Coast Ave.	0	3	4	3	1	3.18	11
Brookline Blvd. between Queensboro & Merrick	1	3	2	1	4	3.36	11
Brookline Blvd. between Pioneer Ave. & Queensboro	1	2	3	1	4	3.45	11

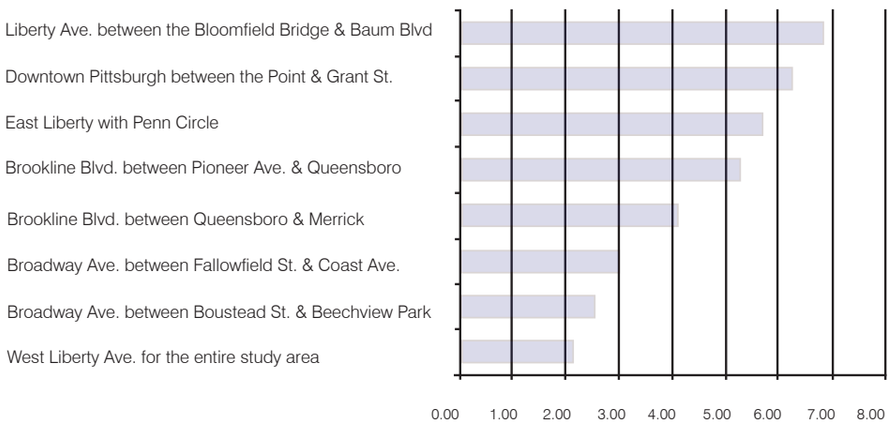
Answered Question: 11
Skipped Question: 0



Question 2: Now, rank the same main street areas with the following additional areas. Again, use 1 as the least connected, and 8 as most connected.

Answer Options	1	2	3	4	5	6	7	8	Rating Average	Response Count
West Liberty Ave. for the entire study area	5	0	1	0	0	0	1	0	2.14	7
Broadway Ave. between Boustead St. & Beechview Park	1	4	1	0	0	1	0	0	2.57	7
Broadway Ave. between Fallowfield St. & Coast Ave.	1	2	1	2	1	0	0	0	3.00	7
Brookline Blvd. between Queensboro & Merrick	0	1	1	2	2	1	0	0	4.14	7
Brookline Blvd. between Pioneer Ave. & Queensboro	0	0	1	0	2	4	0	0	5.29	7
East Liberty within Penn Circle	0	0	1	1	2	0	1	2	5.71	7
Downtown Pittsburgh between the Point and Grant Street	0	0	1	1	0	0	3	2	6.29	7
Liberty Avenue between the Bloomfield Bridge and Baum Blvd.	0	0	0	1	0	1	2	3	6.86	7

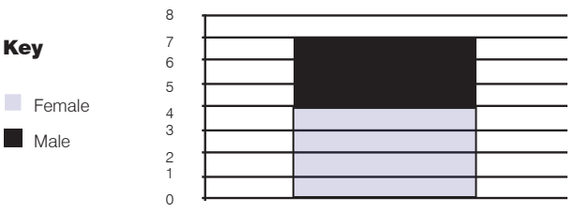
Answered Question: 7
Skipped Question: 4



Question 3: The next few questions are for statistical comparisions only. Gender:

Answer Options	Male	Female	Response Count
Gender	3	4	7

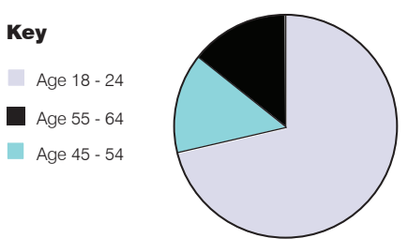
Answered Question: 7
Skipped Question: 4



Question 4: What is your age?

Answer Options	Response Percent	Response Count
18 to 24	71.4%	5
25 to 34	0.0%	0
35 to 44	0.0%	0
45 to 54	14.3%	1
55 to 64	14.3%	1
65 to 74	0.0%	0
75 or older	0.0%	0

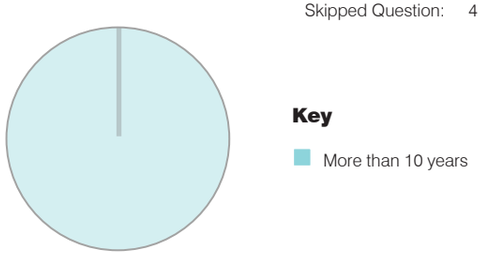
Answered Question: 7
Skipped Question: 4



Question 5: How long have you lived in this country ?

Answer Options	Response Percent	Response Count
Less than 1 year	0.0%	0
Less than 5 years	0.0%	0
Less than 10 years	0.0%	0
More than 10 years	100.0%	7

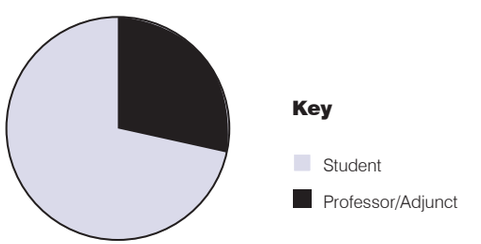
Answered Question: 7
Skipped Question: 4



Question 6: Your role in the Urban Lab class.

Answer Options	Response Percent	Response Count
Professor/Adjunct	28.6%	2
Student	71.4%	5

Answered Question: 7
Skipped Question: 4



Question 7: Please add any comments or observations as they relate to the issue of connectivity. This might include thoughts on what constitutes connectivity, factors that influence the connectivity of one street over another, etc. For example, are there particular reasons that draw you to any of these main streets over others? Possible factors might include: proximity to your daily patterns; unique selling points; easy access to parking; easy access to public transportation. Your input will help us to develop our concepts and theories and focus future research.

Answer Options	Response Count
	1

Answered Question: 1
Skipped Question: 10

6.4 Statistics

2011 Business Summary	Number of Bussiness	Number of Employees	Employee/ Residential Population Ratio*	Major Industries
Brookline Avenue, Brookline	129	754	0.14	Retail Trade, Automotive Repair &Maintenance, Accommodation and Food Services
Broadway Avenue, Beechview	55	428	0.11	Retail Trade, Automotive Repair & Maintenance, Accommodation and Food Services
Penn Circle, East Liberty	526	7.031	1.02	Food & Beverage Stores, Retail Trade, Other Services
Walnut Street, Shadyside	394	4.107	0.42	Professional, Scientific, & Tech Services, Clothing & Accessories Stores, Health Care & Social Assistance
Liberty Avenue, Bloomfield	485	7.364	0.77	Health Care & Social Assistance, Food Services & Drinking Places, Health & Personal Care Stores, Real Estate

* (Left page first table)This ratio indicates the number of employees working in the area versus the number of residents. A higher ratio indicates more commercial presence.

2010 Educational Attainment (Ages 25+)	Brookline	Broadway	Penn Circle Commercial District (2 min drive)	Walnut Street Commercial District (2 min drive)	Liberty Avenue Trade Area
No High School Diploma	7.90%	12.70%	9.60%	3.10%	11.60%
High School Diploma or Some College	59.20%	56.00%	38.40%	15.10%	41.90%
Associates Degree	10.10%	10.90%	6.10%	4.70%	7.80%
Bachelor's Degree	15.70%	14.40%	19.80%	32.20%	18.10%
Graduate or Professional Degree	7.10%	6.00%	26.10%	44.90%	20.60%

Spending Potential Index	Brookline District	Broadway (2 min drive)	Penn Circle District	Walnut Street District	Liberty Avenue District
Apparel and Services	59	56	51	72	49
Computers and Accessories	84	81	71	102	71
Education	89	86	71	101	77
Entertainment / Recreation	87	80	66	91	65
Food at Home	87	83	72	96	70
Food away from Home	85	81	72	100	70
Health Care	94	85	64	80	65
Household Furnishing and Equipment	73	68	56	79	56
Investment	86	74	55	78	58
Retail Goods	83	78	63	86	63
Shelter	80	74	71	99	67
TV / Video / Sound Equipment	87	83	72	97	70
Travel	80	71	60	87	60
Vehicle Maintenance and Repairs	85	80	67	92	66
Note: The Spending Potential Index is household-based, and represents the asset value or amount spent for a product or service relative to the national average of 100. Values higher than 100 indicate spending above the national average, and values lower than 100 indicate lower spending than the national average					

2010 Households by Disposable Income	Brookline	Broadway	Penn Circle	Walnut Street	Liberty Avenue
<$15,000	12.90%	11.40%	31.00%	21.80%	23.60%
$15,000—$24,999	13.20%	16.00%	18.10%	15.90%	21.10%
$25,000—$34,999	14.50%	18.10%	13.80%	14.80%	15.60%
$35,000—$49,999	19.20%	20.70%	13.30%	14.50%	14.40%
$50,000—$74,999	28.00%	25.00%	13.60%	15.70%	16.90%
$75,000—$99,999	7.50%	5.60%	4.20%	6.50%	4.60%
$100,000—$149,999	3.30%	2.50%	3.30%	6.10%	2.70%
$150,000	1.40%	0.70%	2.70%	4.80%	1.10%
Median Disposable Income	$40,937	$37,314	$25,489	$32,903	$27,696

Brookline Demographice Data	2000	2010	2015 (Projected)	Annual Rate of Change*
Population	8,884	8,295	8,048	-0.60%
Households	3,797	3,638	3,554	-0.47%
Median Age	38.2	40.7	41.7	0.49%
% 0-9	12.20%	12.10%	11.60%	-0.83%
% 10-19	11.50%	11.50%	11.70%	0.35%
% 20-24	5.8%	5.5%	5.5%	0.0%
% 20-24	15.4%	13.0%	12.60%	-0.62%
% 35-44	15.6%	14.4%	12.8%	-2.22%
% 45-54	13.9%	15.2%	14.5%	-0.92%
% 55-64	8.1%	12.8%	13.9%	1.72%
% 65+	17.4%	15.6%	17.4%	2.31%
Median Household Income	$36,675	$52,749	$58,486	2.09%
Average Household Income	$43,619	$58,858	$65,692	2.22%
Per Capita Income	$18,665	$25,707	$28,880	2.36%
Total Housing Units	3,969	3,962	3,928	-0.17%
% Owner Occupied Units	67.1%	63.6%	62.4%	-0.38%
% Renter Occupied Units	27.8%	28.2%	28.1%	-0.07%
% Vacant Housing Units	5.0%	8.2%	9.5%	3.17%
Median Home Value	$65,852	$99,974	$124,596	4.16%

Broadway Demographice Data	2000	2010	2015 (Projected)	Annual Rate of Change*
Population	5,114	4,646	4,487	-0.69%
Households	2,123	1,980	1,924	-0.57%
Median Age	36.4	39.2	40.6	0.7%
% 0-9	11.9%	11.2%	10.8%	-0.08%
% 10-19	11.9%	11.1%	10.3%	-0.16%
% 20-24	7.4%	6.6%	6.6%	0.0%
% 20-24	16.5%	14.8%	14.0%	-0.16%
% 35-44	16.6%	14.9%	14.4%	-0.1%
% 45-54	13.0%	16%	14.5%	-0.3%
% 55-64	6.9%	12.1%	14.7%	0.52%
% 65+	16%	13.3%	12%	-0.26%
Median Household Income	$34,676	$45,263	$50,994	2.40%
Average Household Income	$43,771	$55,253	$61,560	2.19%
Per Capita Income	$18,636	$24,037	$26,981	2.34%
Total Housing Units	2,287	2,247	2,228	-0.57%
% Owner Occupied Units	60.0%	55.5%	53.2%	-1.03%
% Renter Occupied Units	32.9%	32.6%	33.1%	0.3%
% Vacant Housing Units	7.1%	11.9%	13.7%	3.02%
Median Home Value	$53,964	$82,737	$103,870	5.10%

* Annual Rate of Change for 2010-2015

Penn Circle District East Liberty Demographice Data	2000	2010	2015 (Projected)	Annual Rate of Change*
Population	16,712	15,524	15,059	-0.61%
Households	8,604	8,104	7,891	-0.53%
Median Age	34.3	35.7	35.8	0.06%
% 0-9	11.0%	10.5%	10.3%	-0.38%
% 10-19	10.0%	9.6%	9.1%	-1.04%
% 20-24	10.1%	10.1%	9.5%	-1.19%
% 20-24	20.2%	18.8%	19.9%	1.17%
% 35-44	14.5%	13.7%	13.2%	-0.73%
% 45-54	11.8%	12.7%	11.8%	-1.42%
% 55-64	7.5%	10.1%	10.6%	0.99%
% 65+	15.0%	14.5%	15.5%	1.38%
Median Household Income	$24,773	$31,913	$37,342	3.19%
Average Household Income	$38,949	$46,160	$53,844	3.13%
Per Capita Income	$20,774	$24,492	$28,658	3.19%
Total Housing Units	9,952	9,807	9,758	-0.10%
% Owner Occupied Units	22.5%	20.3%	19.4%	-0.89%
% Renter Occupied Units	64.1%	62.4%	61.5%	-0.29%
% Vacant Housing Units	13.4%	13.4%	19.1%	8.51%
Median Home Value	$71,000	$107,377	$120,217	2.39%

Walnut Street Commercial District Demographice Data	2000	2010	2015 (Projected)	Annual Rate of Change*
Population	13,641	12,910	12,558	-0.55%
Households	7,978	7,617	7,430	-0.49%
Median Age	31.1	32.4	32.1	-0.19%
% 0-9	5.2%	5.3%	5.3%	0.0%
% 10-19	4.8%	4.5%	4.2%	-1.33%
% 20-24	18.1%	16.8%	15.0%	-2.14%
% 20-24	30.7%	30.6%	31.4%	0.52%
% 35-44	11.8%	13.2%	14.0%	1.21%
% 45-54	10.0%	9.4%	9.4%	0.0%
% 55-64	6.4%	8.1%	7.9%	-0.39%
% 65+	12.9%	12.1%	12.8%	1.16%
Median Household Income	$32,974	$40,208	$50,932	4.84%
Average Household Income	$56,359	$63,210	$74,512	3.34%
Per Capita Income	$33,437	$37,919	$44,811	3.4%
Total Housing Units	8,527	8,362	8,270	-0.22%
% Owner Occupied Units	22.9%	21.0%	20.0	-0.95%
% Renter Occupied Units	70.8%	70.8%	69.8%	-0.28%
% Vacant Housing Units	6.3%	6.3%	10.2%	12.38%
Median Home Value	$152,640	$243,401	$286,465	3.54%

* Annual Rate of Change for 2010-2015

Liberty Avenue Commercial District Demographice Data	2000	2010	2015 (Projected)	Annual Rate of Change*
Population	10,164	9,375	9,076	-0.65%
Households	5,497	5,190	5,055	-0.53%
Median Age	37.1	39.8	41.8	1.01%
% 0-9	7.2%	7.0%	7.0%	0.0%
% 10-19	7.0%	6.3%	6.2%	-0.32%
% 20-24	10.4%	8.3%	8.0%	-0.72%
% 20-24	22.4%	20.7%	18.8%	-1.84%
% 35-44	13.9%	14.6%	14.6%	0.0%
% 45-54	12.9%	13.2%	12.8%	-0.61%
% 55-64	7.8%	11.7%	12.1%	0.68%
% 65+	18.3%	18.3%	20.5%	2.40%
Median Household Income	$24,654	$32,747	$39,262	3.7%
Average Household Income	$34,712	$45,572	$52,908	3.03%
Per Capita Income	$18,836	$25,477	$29,753	3.15%
Total Housing Units	6,116	5,968	5,924	-0.15%
% Owner Occupied Units	31.3%	29.1%	27.9%	-0.82%
% Renter Occupied Units	58.4%	57.9%	57.4%	-0.17%
% Vacant Housing Units	10.2%	13.0%	14.7%	2.62%
Median Home Value	$60,292	$87,088	$104,254	3.94%

* Annual Rate of Change for 2010-2015

Brookline Marketplace Profile**	Retail Potential (Demand)	Retail Sales (Supply)	Retail Gap	Leakage/ Surplus Factor	Number of Business
Motor Vehicle & Parts Dealers	$10,205,609	$3,757,117	$6,448,492	46.2	1
Furniture & Home Furnishing Stores	$1,192,022	$0	$1,192,022	100	0
Electronics and Appliance Stores	$1,527,287	$0	$1,527,441	100	0
Building Materials, Garden Equip. & Supply Stores	$1,622,598	$0	$1,622,598	100	0
Food and Beverage Stores	$8,444,562	$3,406,004	$5,038,558	42.5	4
Health and Personal Care Stores	$2,232,195	$2,921,207	-$689,012	-13.4	3
Gasoline Stations	$7,638,745	$6,839,975	$798,770	5.5	1
Clothing & Clothing Accessories Stores	$2,014,278	$100,482	$1,913,796	90.5	1
Sporting Goods / Hobby / Music / Book Stores	$725,592	$43,362	$682,230	88.7	0
General Merchandise Stores	$6,094,433	$81,961	$6,012,472	97.3	1
Nonstore Retailers	$2,026,605	$0	$2,026,605	100	0
Food Services & Drinking Places	$7,437,073	$3,247,111	$4,198,961	39.2	14

Broadway Marketplace Profile**	Retail Potential (Demand)	Retail Sales (Supply)	Retail Gap	Leakage/ Surplus Factor	Number of Business
Motor Vehicle & Parts Dealers	$7,266,477	$16,277,181	-8960704	-38.1	3
Furniture & Home Furnishing Stores	$814,263	$621,534	$192,729	13.4	1
Electronics and Appliance Stores	$1,080,822	$0	$1,080,822	100.0	0
Building Materials, Garden Equip. & Supply Stores	$1,062,307	$498,862	$563,445	36.1	1
Food and Beverage Stores	$6,013,411	$7,102,851	-$1,089,440	-8.3	4
Health and Personal Care Stores	$1,549,511	$0	$1,549,511	100	0
Gasoline Stations	$5,548,455	$735,481	$4,812,974	76.6	0
Clothing & Clothing Accessories Stores	$1,431,967	$37,437	$1,394,530	94.9	0
Sporting Goods / Hobby / Music / Book Stores	$526,795	$0	$526,795	100	0
General Merchandise Stores	$4,302,827	$0	$4,302,827	100	0
Nonstore Retailers	$1,398,291	$1,038,950	$359,341	14.7	1
Food Services & Drinking Places	$5,241,116	$1,631,652	$3,609,464	52.4	5

**Supply (retail sales) estimates sales to consumers by establishments. Sales to businesses are excluded. Demand (retail potential) estimates the expected amount spent by consumers at retail establishments. The Leakage/ Surplus Factor measures the relationship between supply and demand that ranges from +100 (total leakage) to -100 (total surplus). A positive value represents 'leakage' of retail opportunity outside the trade area. A negative value represents a surplus of retail sales, a market where customers are drawn in from outside the trade area. The Retail Gap represents the difference between Retail Potential and Retail Sales. The NAICS is used to classify businesses by their primary type of economic activity.

Penn Circle Commercial District (2 min Drive) Marketplace Profile**	Retail Potential (Demand)	Retail Sales (Supply)	Retail Gap	Leakage/ Surplus Factor	Number of Business
Motor Vehicle & Parts Dealers	$14,175,619.00	$1,892,238.00	$12,283,382.00	76.4	4
Furniture & Home Furnishing Stores	$1,678,651.00	$5,511,086.00	-$3,832,435.00	-53.3	7
Electronics and Appliance Stores	$2,201,196.00	$1,866,964.00	$334,232.00	8.2	5
Building Materials, Garden Equip. & Supply Stores	$1,987,608.00	$23,065,801.00	-$21,078,193.00	-84.1	5
Food and Beverage Stores	$12,444,254.00	$87,934,288.00	-$75,490,035.00	-75.2	11
Health and Personal Care Stores	$2,937,194.00	$4,229,378.00	-$1,292,184.00	-18	4
Gasoline Stations	$10,488,210.00	$11,064,551.00	-$576,341.00	-2.7	2
Clothing & Clothing Accessories Stores	$3,091,009.00	$5,526,306.00	-$2,435,297.00	-28.3	20
Sporting Goods / Hobby / Music / Book Stores	$1,087,605.00	$3,190,753.00	-$2,103,148.00	-49.2	5
General Merchandise Stores	$8,703,843.00	$9,504,529.00	-$800,686.00	-4.4	4
Nonstore Retailers	$2,731,244.00	$0.00	$2,731,244.00	100	0
Food Services & Drinking Places	$11,286,891.00	$18,467,969.00	-$7,181,078.00	-24.1	33

Walnut Street Commercial District (2 min Drive) Marketplace Profile**	Retail Potential (Demand)	Retail Sales (Supply)	Retail Gap	Leakage/ Surplus Factor	Number of Business
Motor Vehicle & Parts Dealers	$25,299,458.00	$0.00	$25,299,458.00	100	0
Furniture & Home Furnishing Stores	$3,060,793.00	$11,760,678.00	-$8,699,885.00	-58.7	8
Electronics and Appliance Stores	$3,943,318.00	$1,398,059.00	$2,545,259.00	47.7	4
Building Materials, Garden Equip. & Supply Stores	$3,616,287.00	$1,084,380.00	$2,531,907.00	53.9	2
Food and Beverage Stores	$21,500,866.00	$42,970,600.00	-$21,469,734.00	-33.3	7
Health and Personal Care Stores	$4,918,755.00	$7,861,315.00	-$2,942,560.00	-23.0	7
Gasoline Stations	$18,046,582.00	$2,308,699.00	$15,737,884.00	77.3	0
Clothing & Clothing Accessories Stores	$5,559,050.00	$26,001,191.00	-$20,442,142.00	-64.8	41
Sporting Goods / Hobby / Music / Book Stores	$1,936,410.00	$2,711,387.00	-$754,977.00	-16.2	4
General Merchandise Stores	$15,248,381.00	$792,480.00	$14,455,901.00	90.1	2
Nonstore Retailers	$4,753,666.00	$0.00	$4,753,666.00	100	0
Food Services & Drinking Places	$20,220,686.00	$21,289,172.00	-$1,068,486.00	-2.6	39

**Supply (retail sales) estimates sales to consumers by establishments. Sales to businesses are excluded. Demand (retail potential) estimates the expected amount spent by consumers at retail establishments. The Leakage/ Surplus Factor measures the relationship between supply and demand that ranges from +100 (total leakage) to -100 (total surplus). A positive value represents 'leakage' of retail opportunity outside the trade area. A negative value represents a surplus of retail sales, a market where customers are drawn in from outside the trade area. The Retail Gap represents the difference between Retail Potential and Retail Sales. The NAICS is used to classify businesses by their primary type of economic activity.

Liberty Avenue Commercial District (2 min Drive) Marketplace Profile**	Retail Potential (Demand)	Retail Sales (Supply)	Retail Gap	Leakage/ Surplus Factor	Number of Business
Motor Vehicle & Parts Dealers	17447989	60760426	-43312437	-55.4	13
Furniture & Home Furnishing Stores	2021888	1041068	980918	32.0	1
Electronics and Appliance Stores	2691716	469299	2222417	70.3	2
Building Materials, Garden Equip. & Supply Stores	2497145	1629882	867263	21.0	4
Food and Beverage Stores	15111424	50210674	-35099250	-53.7	7
Health and Personal Care Stores	3665672	7527950	-3862278	-34.5	6
Gasoline Stations	13194269	18166394	-4972125	-15.9	4
Clothing & Clothing Accessories Stores	3719841	1396125	2323716	45.4	11
Sporting Goods / Hobby / Music / Book Stores	1357225	1183525	173701	6.8	7
General Merchandise Stores	10634967	6677051	3957916	22.9	5
Nonstore Retailers	3480304	2888180	592124	9.3	2
Food Services & Drinking Places	13495193	21344977	-7849784	-22.5	51

6.5 Bibliography

"A natural ecosystem is defined as "composed of physical-chemical-biological processes active within a space-time unit of any magnitude." A city ecosystem is composed of physical-economic-ethical processes active at a given time within a city and its close dependencies."

- Jane Jacobs, Forward to the 1992 Modern Library Edition of The Death and Life of Great American Cities

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"The tree of my title is not a green tree with leaves. It is the name of an abstract structure. I shall contrast with another, more complex abstract structure called a semilattice… It is more and more widely recognized today that there is some essential ingredient missing from artificial cities. When compared with ancient cities that have acquired the patina of life, our modern attempts to create cities artificially are, from a human point of view, entirely unsuccessful…" –Christopher Alexander.

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