WALKABILITY ANALYSIS OF THE SELF-GUIDED WALKING TOUR IN DOWNTOWN DURHAM, NORTH CAROLINA

by

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Honors Thesis

Appalachian State University

Submitted to the Department of Sustainable Technology and the Built Environment
and The Honors College
in partial fulfillment of the requirements for the degree of

Bachelor of Science

August, 2015

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INTRODUCTION

Overview of Downtown Revitalization Efforts

The "Rust Belt" of the northeastern and Midwestern sections of the United States refers specifically to its small industrial cities (e.g., Rochester, New York) which have experienced suburban flight, depressed and outsourced manufacturing economies, and crumbling downtowns in the latter half of the 20th century (Tumber, 2012); however, these cities are also opportunities to pursue more energy efficient, petroleum-independent economic revitalization. The density of these cities coupled with their proximity to surrounding agricultural areas allows for more locally sustainable populations. This density also offers the possibility of more diverse transportation options and an overall move towards less petroleum fuel use (e.g., Rochester public buses also serve as school buses to reduce public fuel costs), including the potential for walkable neighborhoods that do not require use of cars or buses to attend to basic needs (Tumber, 2012). Current public policies in the U.S. theoretically and practically focus on addressing the needs of either high-density metropolitan areas or low-density rural areas; this "Wall Street - Main Street dyad" (Tumber, 2012, p. xvi, xxvi) generally excludes meaningful discussion around the in-between places, namely, small and medium-density cities. Tumber's attention to the small city, the definition of which is admittedly more fluid and nuanced than the metropolis or rurality, is especially important because the discussion is lacking. Tumber identifies downtown areas of small cities, specifically formerly industrial cities of the Rust Belt, as potential places for sustainable growth and revitalization (Tumber, 2012).

The downtown areas of many small and mid-size cities in the U.S. were economically and socially gutted with the rapid rise of suburban neighborhoods, especially in the 1950s. This nationwide move outwards exemplified the so-called "American Dream" of homeownership and also paved the way for America's car culture. Yet, that suburban flight left formerly thriving downtown areas plagued with poverty and crime. It also fostered an ongoing dependence on fossil fuel consumption for suburban homeowners (Soderstrom, 2008). More recently, proponents of sustainable urban living—which addresses in part the need for less energy-intensive lifestyles—have pushed for the revitalization of these downtown areas (Tumber, 2012).

Besides conserving transportation energy, the vast majority of which is still liquid fossil fuels in the United States, a thriving, walkable downtown area has social, economic, health, and safety benefits, as Soderstrom explains in *The Walkable City: From Haussmann's Boulevards to Jane Jacobs' Streets and Beyond*. Jane Jacobs, a grassroots advocate of walkable neighborhoods, identifies several of these benefits in her hugely influential work *The Death and Life of Great American Cities,* published in 1961 (Soderstrom, 2008). Narrower studies have also been conducted for each of these specific benefits to downtown health. One such study investigating walkability and social capital in New Hampshire communities found that high walkability strongly correlated to high social capital, which is "a measure of an individual's or group's networks, personal connections, and involvement" (Rogers, Halstead, Gardner, & Carlson, 2010, p.1). Social capital is acknowledged as a significant factor in individual quality-of-life measures, so the correlation between high walkability and high social capital in this study presents a strong argument for

further research into the relationship between walkability and quality of life. Social capital, in addition to the other aforementioned benefits, shows that walkability relates directly to the health and stability of a downtown community.

The 1987 Brundtland Report of the United Nations, more widely known as *Our Common Future*, set the tone for subsequent urban renewal and sustainability efforts in the United States. This report defines sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987, para. 1). In more concrete terms, the interaction of economy, environment, and equity (i.e., social equity, the fair division of public resources for public policies) is the foundation upon which a sustainable community is built (NLC Sustainable Cities Institute, 2013a). These elements are not independent of each other; indeed, walkability interacts with the different elements of sustainability in multiple ways. Research here is focused on the role or roles that walkability plays in the environmental sustainability of the downtown community.

Walkability as an Essential Component of Downtown Revitalization

"Walkability" here refers to the ease and desirability of walking within an area, typically a neighborhood, city district, or other defined community. Walking paths are the simplest, most compact, and most democratic form of transportation, so they are essential to the mobility (i.e., the ease of moving from one place to another) and economy of a downtown area. Because walking correlates directly to a reduction in driving and its associated pollution concerns, creating walkable communities is desirable from an environmental preservation perspective. Other benefits of making communities more walkable include stronger social

connections, more economically stable local businesses, and improved health of the local population (NLC Sustainable Cities Institute, 2013b). This study investigates how walkability corresponds to environmental sustainability, specifically a reduced need for fuel vehicle transportation, in the context of the City Center district of Downtown Durham, North Carolina.

The National Complete Streets Coalition (NCSC), founded in 2004 as a subset of Smart Growth America, is an organization dedicated to improving transportation within a community by making it safe and effective for all street users. The push for "complete streets," (i.e., streets that can be used safely and easily by pedestrians and bicyclists as well as drivers) is the community response to the "incomplete streets" that realistically accommodate automobiles only. According to NCSC, the benefits of implementing a Complete Streets policy in a community include a more robust local economy, improved safety and mobility for those unable to use cars (e.g., schoolchildren and the elderly), improved physical health and lower obesity rates, and lower transportation costs (NLC Sustainable Cities Institute, 2013b). Lower transportation costs naturally correspond to lower fuel use in vehicles, which also corresponds to less environmental damage from fossil fuel consumption.

Recent Durham Downtown Revitalization Efforts

The City of Durham's recent publications reflect community efforts to revitalize the downtown area within a more comprehensive set of goals for Durham's growth as a sustainable city. These major goals are stated in the most recent publication of the city's *Strategic Plan*, last updated in April 2013. The specific subheadings of each goal express an increased commitment towards a more locally-focused, walkable, safe community. Examples

include “promotion of small business and local business,” “vibrant downtown where people live and work,” “energy efficiency,” and “well-lit community,” among others (Durham City Council, 2014, pp.11-13). The push for sustainability can be summed up neatly in the document’s “Statement of Vision,” which reads “Durham is the leading city in providing an excellent and sustainable quality of life” (p.6). Each sustainability-focused subheading includes concrete intermediate methods to accomplish these goals and to quantitatively measure those accomplishments (p.16-26).

The City of Durham has worked closely with community organizations, notably Downtown Durham, Inc. (DDI), to conduct studies of the downtown area for concrete recommendations for change. DDI, formed in 1993, is a nonprofit commercially-oriented organization for the promotion of local businesses and the overall revitalization of the Downtown area. Membership is open to stakeholders in Downtown Durham redevelopment; current Board members include local government officials, small business owners, real estate developers, law firms, banks, and energy providers. DDI’s mission is to “create an environment for private development in Downtown Durham by focusing our efforts in five main project areas: economic development, parking, appearance, safety, and promotion” (Scarborough, 1998, para. 1). DDI has accomplished these mission objectives, in part, by forming committees for advising the City Council on development related to these stated project areas, as well as by managing a street team of volunteers to increase downtown cleanliness, safety, and visitor hospitality. DDI’s completed projects focus on the economic revitalization of downtown through retail market analyses, parking studies, and a

comprehensive set of resources for potential business owners and investors (Downtown Durham Master Plan, 2011, pp.14-30).

Beyond the City Council and DDI, the Durham business community has made great strides in actively promoting the revitalization of its downtown. Over 100 local businesses in Durham participate in the grassroots Sustain-a-Bull movement, which promotes a small, locally-focused economy for greater economic, social, and environmental stability (Sustain-a-Bull, 2015). Other individual businesses and non-profits include environmental sustainability in their business models. Two long-standing examples are the Durham Scrap Exchange, which serves as a hub for Durham's sizable re-use and recycling market, and the Durham County Farmer's Market, which provides locally-produced food and goods. So, the greater Durham community already shows commitment to sustainable city life, of which a flourishing downtown is a crucial part.

Statement of the Problem

Although Durham has been moving forward in revitalizing its downtown, there is more to accomplish in terms of improving walkability, reducing reliance on vehicle travel, and visibly promoting a more environmentally sustainable community. By providing suggestions to improve the walkability of the self-guided walking tour in the City Center district of Downtown Durham, I hope to further encourage local commitment to a walkable, sustainable downtown.

Research Questions

What characteristics of the current Downtown Durham self-guided walking tour affect its usability and attractiveness to pedestrians? What strategies might be used to enhance the walkability and overall appeal of those street sections to pedestrians?

Significance of the Study

The Durham Visitor Information Center currently offers a self-guided walking tour of Downtown Durham which consists of one main, circular route in the Center City district as well as several secondary routes branching into the surrounding downtown districts (e.g., American Tobacco, Warehouse, Brightleaf, etc.). This walking tour, specifically the main route, provided an established pedestrian route with which I was able to narrow the focus of my research into a manageable portion. I analyzed this small, well-marked portion of Downtown Durham in order to discover those elements that actually affect the walkability of the self-guided walking route and that could be added to or modified in order to increase the pedestrian appeal of the route.

The walkability analysis conducted in this study used a pedestrian-oriented modification of the traditional, long-standing Level of Service (LOS) system of measurement for a quantitative analysis of ten (10) specific street segments. Additionally, a detailed series of map layers (using Google Maps API), showing those street elements which are closely linked to walkability, provided a corresponding qualitative analysis. Combined, these analyses exposed the visual differences between those sections of the walking tour which had especially high or low levels of walkability. Using additional elements from a Complete Streets case study in Charlotte, NC (McCann & Rynne, 2010) as guidelines for street

modification, I provided suggestions for specific changes to the existing main route to increase the overall walkability of the Downtown Durham self-guided walking tour.

Limitations of the Study

The observational data were collected once and the Pedestrian Level of Service (PLOS) collection procedure was conducted by a student without professional experience in the field of urban planning. The PLOS scores themselves are limited tools; they require qualitative interpretation within the social and cultural context of Durham, the extent of which is beyond the scope of this study. Criteria for the PLOS focuses on the transportation aspect of walkability and so does not include the experiential aspects of the walking tour (i.e., specific aspects of the built environment beyond the sidewalk) that affect its pedestrian appeal. The scope of the PLOS study was limited to the Main Route of the Downtown Durham self-guided walking tour, marked by arrows in the self-guided walking tour map, as shown in Figures 1 and 2.

The study was therefore limited to the central route of the walking tour, which is unlikely to include all of the characteristics of the surrounding Downtown area despite being its hub. Additionally, the route used does not require crossing any of the major arteries of Durham (e.g., the Downtown Loop, Duke Street, etc.), even though such streets have proven to be pedestrian barriers between Downtown and the surrounding neighborhoods

(*DurhamWalks! Pedestrian Plan*, 2011, pp.4, 15-20).[1] The constantly changing nature of Downtown Durham's built environment dates the usefulness of the study as many areas addressed in the analysis (e.g., CCB Plaza) have been marked for revitalization (Durham City Council, 2014; Kimley-Horn and Associates, Inc., 2010; Scarborough, 1998). Finally, the qualitative sections in the supporting walkability map may not include all of the physical elements which actually affect the walkability of the Downtown area, and so may not adequately address the complexity of the relationships between walkability elements and elements of environmental sustainability.

[1] Durham's local newspaper, *The Herald-Sun*, publishes announcements for city meetings addressing such problematic roads as the Downtown Loop and Highway 15-501, as well as Letters to the Editor addressing the growth and walkability of Downtown Durham. Archives of these publications can be found online at http://www.heraldsun.com with the search tag "downtown walkability."

Figure 1. Self-guided walking tour of Downtown Durham. This figure illustrates the central, circular route from which secondary routes extend into the surrounding Downtown districts.

Figure 2. Main route of the self-guided walking tour. This figure illustrates the main route marked in purple arrows as well as numbered places of interest, indicating that the marked route is a guideline only and that exploration of those places is encouraged.

REVIEW OF LITERATURE

Urban Revitalization Goals and Principles

Case study: Complete Streets in Charlotte, NC.

The Complete Streets movement began as a grassroots effort to expand the accessibility of streets to all users, not just to automobile users. Today, Complete Streets is a national movement and its principles of street design (e.g., buffer zones, bicycle lanes, speed limits, etc.) have been adapted for use in municipalities across the United States. Walkability is an essential part of the Complete Streets movement and one which is reflected in cities' adaptations. McCann and Rynne (2010) use a series of case studies to illustrate those elements of the street that contribute to or detract from the complete street ideal.

Since retrofitting street elements (e.g., sidewalks, tree buffers, etc.) to Complete Streets standards tends to be extremely expensive, the Complete Streets movement advocates inclusion of their standards in the planning and cost analysis for new developments. Although they may increase initial project estimates, they are typically far cheaper than retrofitting; a main goal of the Complete Streets movement is to establish those elements as a necessary and normal part of transportation design standards (McCann & Rynne, 2010).

One recurring issue for Complete Streets movements in the United States is the problem of sidewalk construction and maintenance. Although sidewalks are public pathways, they are very often surrounded by private property. American laws generally hold the owners of private property responsible for the construction and maintenance (including snow removal) of adjacent sidewalks. This creates a patchwork system of sidewalk conditions that may deter public use and decrease the walkability of the community. McCann and Rynne

(2010) point to the methods employed by Colorado Springs, CO, and Charlotte, NC, as successful policies which addressed walkability issues caused by an inconsistent sidewalk network. The former municipality reclassified sidewalk construction and maintenance as a city responsibility, and the latter established a sidewalk retrofit program which constructed and repaired sidewalks where residents requested them (p.62).

Charlotte is an especially apt case study for comparison to Durham as both are subject to North Carolina state laws and regulations in regard to planning, traffic, and other city council functions. Additionally, both are in the same climate region with similar weather patterns and concerns. Charlotte is relatively similar to Durham[2], so its method of restructuring sidewalk responsibilities and policies for pedestrian networks would be a useful case study from which Durham might incorporate elements.

The City of Charlotte used a series of surveys to document that residents preferred the visual and functional landscape of its complete streets (e.g., ones with more trees and plant buffers along sidewalks, and more bicycle lanes) to its more incomplete ones. This feedback from the community persuaded the city government to pursue a policy using the values and methodology of previous Complete Streets initiatives (p.73).

The actual policy Charlotte developed relied on an additional street classification system on top of the federal Complete Streets classification system. Charlotte city staff developed five (5) street types ranging from most pedestrian-oriented to most auto-oriented, and in the process set up a prerogative for explicit consideration of all street users. New

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[2] CityTownInfo.com rates Charlotte as being 90.5% similar to Durham, and Durham as being the second-most similar city to Charlotte in the United States. As both cities have similar climates and cultures, and are both under NC state laws, such a conclusion is plausible and useful for a Complete Streets comparison.

development projects are notified of preferred and maximum block lengths to create a walkable system of cross streets and to encourage density. These street considerations are not new ideas; Jane Jacobs championed short city blocks as crucial to a vibrant, walkable community structure (Soderstrom, 2008). Charlotte DOT also created a Sidewalk Retrofit Policy which takes on the responsibility for repair and construction of sidewalks in the city as well as newer subdivisions in Charlotte's surrounding suburbs (*Street and sidewalk maintenance*, 2015). Though they remain responsible for general maintenance (e.g., snow and debris removal, etc.), residents may now petition the City of Charlotte to add or repair sidewalks in a convenient online request form (*Street*, 2015). Throughout the process of adding or retrofitting these sidewalks, input from residents is solicited by the City so that the sidewalk design and location is tailored to maximize pedestrian use (*Street*, 2015).

In addition to block-length regulations and sidewalk responsibilities, Charlotte created a multimodal LOS to supplement the traditionally used vehicle LOS, thus factoring in street accessibility to pedestrians and bicyclists. A specific example of Charlotte's incorporation of Complete Streets in planning policies is shown in its traffic analyses. Instead of recording rush hour traffic congestion over the course of one (1) hour, Charlotte extended the time period to two (2) hours. Where a one-hour analysis might conclude that the streets needed widening to allow more vehicle traffic (thus creating a less friendly environment for pedestrians), the two-hour analysis is more likely to show less vehicle need (thus expanding consideration of street function to the needs of non-vehicle users). Charlotte justified keeping the smaller street crossings with the reasoning that one hour of car congestion would be offset by the continuous state of a higher pedestrian-friendly environment, a decision which

illustrates how Charlotte's street-use priorities have expanded beyond the needs of automobile users alone (McCann & Rynne, 2010). Beyond the physical considerations of the street, Charlotte has improved walkability by adjusting its operational approach to street use: reducing traffic cycles, increasing crosswalk visibility, and adding pedestrian signals. These changes, which cost relatively little money to implement, nevertheless measurably increased pedestrian street use.

The City of Durham could incorporate some of Charlotte's approaches to Complete Streets by similarly changing its protocols of traffic studies to be more inclusive of non-vehicle users on the street. Re-striping current lanes for bicycle use and extending buffer zones would also replicate the layout of Charlotte's more complete streets. Although the Downtown Durham area has a fairly comprehensive network of pedestrian signals and short waits at crosswalks, some crosswalks along the route do need general repair or repainting, and a few points along the route do not have crosswalks at all (Figures 3 through 5).

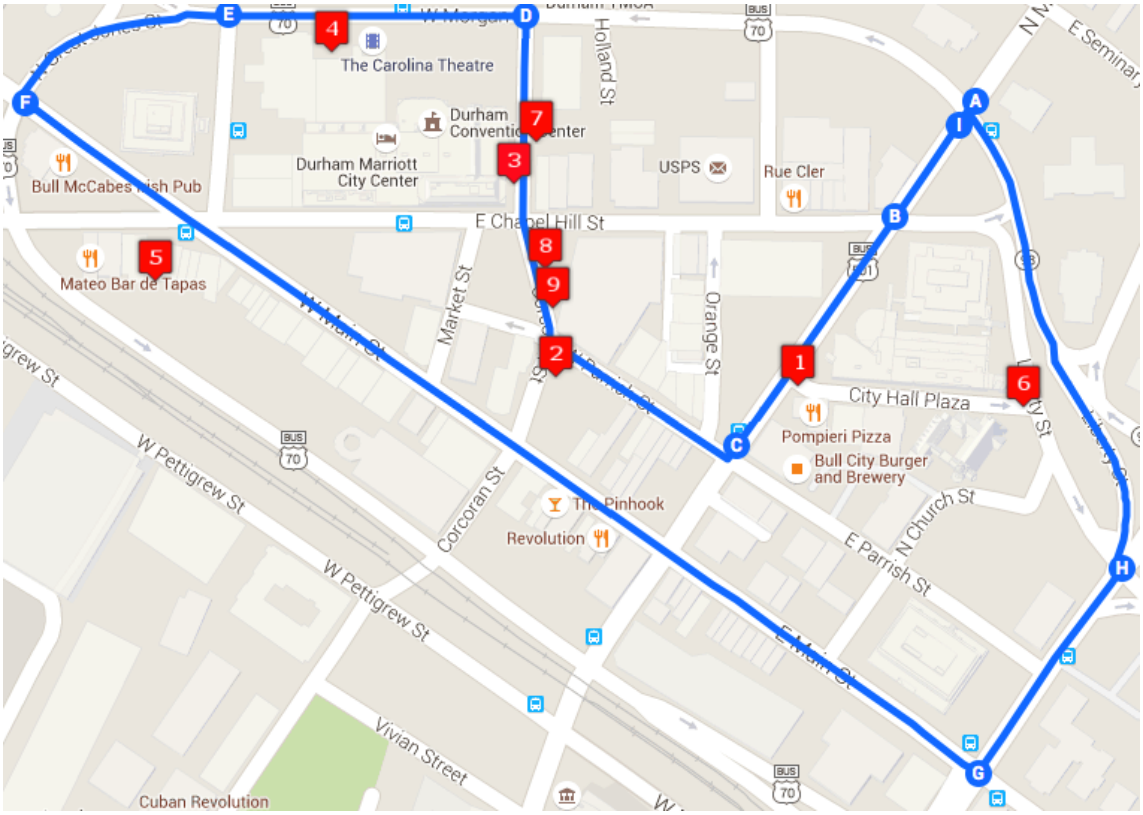

Figure 3. Recommendations map layer. This figure illustrates and addresses issues with physical access to the actual sidewalk and general concerns about the self-guided walking tour, as detailed in Figure 4. This map layer used qualitative data from March 15, 2015.

1	Detour blocking sidewalk	Sidewalk repairs are ongoing across Downtown, which provides overall improvements to sidewalk safety and network accessibility. However, the frequency of required detours during the time of this survey (March 2015) was confusing and tiring, even as an able-bodied person.
2	Lack of signage at crosswalk	Though the street is narrow and traffic is low, current construction sites and street curvature decrease visibility, potentially increasing the danger to pedestrians crossing the street.
3	Lack of curb ramps	The hotel drop-off zone has curb ramps in front of the doors, but not straight across the general sidewalk on Foster Street. Considering the ongoing sidewalk renovations, adding curbs would lessen the inconvenience to the physically handicapped.
4	Low visibility	Poor visibility of service entrance for trucks increases pedestrian risk on the sidewalk. Remodeling the space or removing some latticework could improve visibility, as currently service trucks must reverse out on to the street across the sidewalk.
5	Isolated alley	The alley is a short pedestrian connection space to a parking lot, which does not have adequate lighting. Though the intersection side does have sporadic foot traffic at night, improving the lighting could lessen the isolation of the parking lot from the main intersection.
6	Sidewalk detour, poor crosswalk	Another sidewalk detour required crossing Liberty St. Though the crosswalk was well-marked, the overall poor visibility and high traffic necessitated that I cross quickly. Better lighting or warning signs to cars might improve the safety of that crosswalk.
7	Sidewalk detour	This minor construction site was easily and safely bypassed because the street had low traffic and visible stoplights.
8	Dilapidated area	This public space (CCB Plaza) has low pedestrian usage and borders several closed businesses. Current construction surrounding the plaza, as well as DDI's focus on economic investment in that area, indicate growth in the near future. Extra tree coverage or similar shading efforts to reduce a heat island effect (which is especially noticeable here during warm weather) could also help boost this area's popularity.
9	Lack of crosswalk	A busy parking garage entrance stretches approximately 20 yards and, while it has curb ramps, has no marked crosswalk.

Figure 4. Recommendations map layer key. This figure explains the detailed recommendations corresponding to each numbered point in Figure 3.

Figure 5. Point 9 marked on Figure 3. This figure shows the lack of crosswalk at CCB Plaza.

City of Durham Downtown Revitalization

Brief overview of Durham history.

Durham is a relatively young city, established officially with a small railroad station in 1854, just before the American Civil War. In the post-Civil War South, Durham's economy boomed in the tobacco, textile (e.g., cotton), and banking industries. The industrial warehouses became especially important to Durham's economy (Richardson, n.d.). As shown in Figure 6, those warehouses formed much of the economy and built environment of the original Downtown Durham area (Branson, 1887).

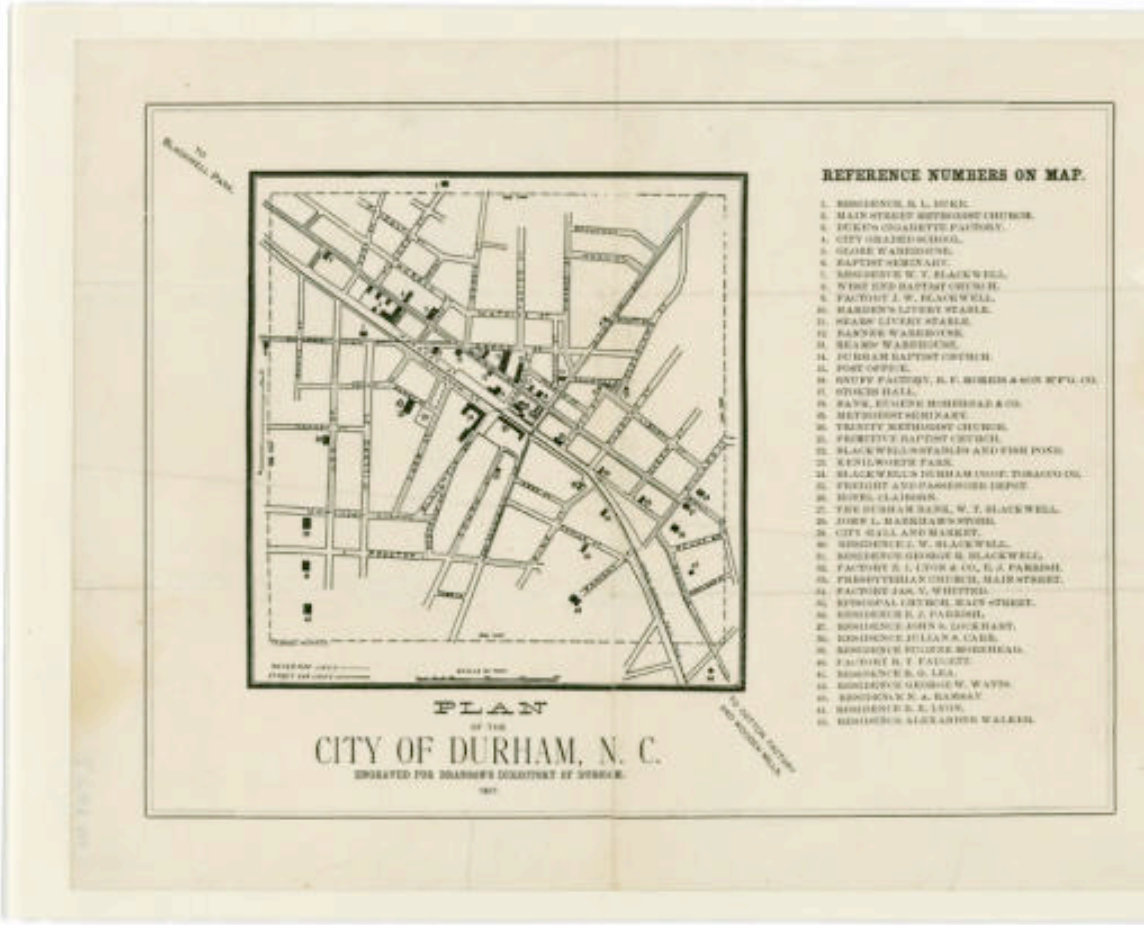

Figure 6. 1887 map of Durham retrieved from the North Carolina Collection in the UNC Archives (Branson, 1887). This figure illustrates the main streets of Durham, NC and their orientation to important buildings, of which ten (10) were industrial warehouses. All of these warehouses were located near the central railroad, which shaped the movement and structure of Downtown Durham from its early stages of urban development.

Durham also defined itself from an early stage as a university town. In 1892, Trinity College (now part of Duke University) was moved into the Old West neighborhood bordering Downtown (Richardson, n.d.). In 1910, North Carolina Central University (NCCU) was founded on Fayetteville Street. As a Historically Black College and University (HBCU)-designated institution, NCCU provided an early hub for Durham's African-American community along with the nearby historic Black Hayti neighborhood (Richardson, n.d.).

In the Center City district of Downtown Durham, several African-American businesses were established along Parrish Street around 1900, notably the Mechanics and Farmers Bank and the NC Mutual Insurance Company (Richardson, n.d.). Parrish Street, part of the self-guided walking tour, was thus dubbed the "Black Wall Street." Many other downtown buildings noted as points of interest on the walking tour (e.g., the Durham Armory, the Kress building, etc.) were built during the New Deal era of the 1930s and have been preserved since (Durham Convention & Visitors Bureau [DCVB], n.d., p.2-3)**.**

Durham continued to be a primarily industrial city through much of the 1900s, but in the 1940s the city began to see the same sort of urban blight and subsequent renewal that Tumber (2012) describes in the Rust Belt; mainly, planning projects focused on bypassing the downtown areas (e.g., the Durham Freeway and the Downtown Loop, which borders part of the walking tour) to allow faster traffic flow. They also focused on movement towards suburbs and large shopping malls (e.g., Northgate Mall in Durham, which borders I-85). Urban renewal[3] efforts gained popularity from the 1950s to 1970s, but many of these were not so much renewal efforts as they were "removal" efforts, which disproportionately affected the poorer and more segregated districts. Whole neighborhoods, including Hayti, were destroyed and their communities displaced, leaving the Downtown and surrounding areas mired in constant construction (Richardson, n.d.).

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[3] Here, 'urban renewal' refers to the historic period of urban design in the U.S. beginning in the 1940s, which was characterized by ambitious projects (e.g. highways, sports and civic centers, etc.) that sought to completely redefine the neighborhoods, traffic patterns, and characters of their respective city locations. Such projects were often government-funded and initialized from the top down through bureaucratic channels (Tumber, 2012). In contrast, 'urban revitalization' refers to recent and ongoing efforts to develop community infrastructure from grassroots levels, and typically focuses on smaller, less grandiose development projects.

During this movement to renew the areas around Downtown Durham and alleviate the gridlock of car traffic, businesses within Downtown often either went bankrupt or moved away from Downtown.[4] With the establishment of Research Triangle Institute (now Research Triangle Park, or RTP) in Durham County in the 1960s, local development efforts and funding shifted from the city to the county. This movement further exacerbated downtown decay and the loss of rural farming communities as they made way for freeways and other sprawling suburban infrastructure. By the 1980s, most factory industries within the city limits had been outsourced to cheaper locales. By 1999, the very last tobacco processing plant in Durham had closed (Richardson, n.d.).

Durham attempted to redefine its economic and cultural identity as the industrial backbone of the city crumbled. Historical and environmental preservation efforts in Downtown Durham and the surrounding neighborhoods, which had been ongoing since the 1960s and 1970s, gained traction in the 1980s with the establishment of the Brightleaf Square shopping center in a set of refurbished tobacco warehouses (Preservation Durham, 2014).

The tobacco warehouses were responsible for Durham's initial economic boom, but in recent years sparked a second wave of development in Downtown Durham. These warehouses represent the history and character of Durham, so their renovation into other spaces is especially symbolic of the city's renewal. With the conversion of the old American Tobacco warehouses into mixed-use facilities (e.g., offices, performance venues, restaurants, etc.), the Downtown American Tobacco Campus district has prospered, exceeding even its

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[4] A comprehensive set of photographs from the Ralph Rogers collection ("Changes in the Landscape of Downtown Durham") in the Durham Co. Library archives provides a thorough illustration of the changes in Downtown Durham's built environment from 1950-2000.

industrial peak productivity. According to Preservation Durham, ". . . more people work in its top-rank offices than toiled there at the peak of American Tobacco's cigarette production" (2014, Education: Durham section, para. 13).

Some converted warehouses (e.g., West Village Apartments) use courtyards and other private additions to form neighborhoods in and of themselves. Although more recent building projects have increased Durham's appeal on their own (of which the most notable examples are the Performing Arts Center [DPAC] and the newer campus for the Durham Bulls Athletic Park [DBAP]), their central placement within Durham's historic infrastructure has encouraged economic growth of the surrounding Downtown area (Durham City Council, 2014).

Downtown Durham walking tours.

The Downtown Durham self-guided walking tour, used here as a framework for analysis of the City Center district in Downtown Durham, is by no means the only or objectively best walking tour in Downtown Durham. Other tours are tailored to more specific subjects (e.g., Civil War, Tobacco Heritage, Downtown Architecture, Hidden Durham, etc.) and are typically guided (Preservation Durham, 2014). The advantage in using this specific tour is that it is self-guided and, as such, designed to be as accessible and interesting to a broad range of tastes as possible. Additionally, this tour gives several interest points off the main marked route, which encourages exploration. The self-navigation and self-paced nature of this tour allows the walker to focus on the walkability of the route without the distraction of a tour guide, thus mimicking the experience of pedestrians in their daily commutes. Information about these walking tours is readily available online and in print format, and is

an effort on the part of the City of Durham to inject a renewed level of vitality to its downtown infrastructure.

Other Features to Enhance Walkability

Walk Score.

Walk Score is an online tool that measures the amount and type of a variety of amenities (e.g., grocery stores) and their distance from a selected address, then calculates a numerical score (0-100) of walkability, ranging from low to high levels of walkability. Since the methodology uses a proprietary algorithm, the description of the calculations (i.e., specific components and their respective weightings in the algorithm) is deliberately vague. One issue with Walk Score is its emphasis on distance as a major factor of walkability even though less quantifiable elements (safety, convenience, visual interest, etc.) may have much more of an effect on the pedestrian appeal of a given route. Also, while Walk Score states that distance determines scoring, it includes such criteria as "pedestrian friendliness" in its calculations (*Walkability research*, n.d.). This qualitative value apparently corresponds to a quantitative population density value, but the relationship between the two values is not explained. Despite these issues, Walk Score is a useful inclusion for this study as a quantitative measure of walkability in addition to the PLOS scores. Walk Score's methodology is neither publicly available, nor does it fit within the scope of this study; however, the advisory board of planning professionals who developed the Walk Score algorithm, as well as the several peer-reviewed academic papers that have used Walk Score data since 2009, give credence to its accuracy and usefulness as an analysis tool for walkability. The City of Durham's overall Walk Score is rated at only 28, meaning it is rated

a car-dependent city, but the Downtown Loop portion (which closely follows the main arc of the self-guided walking tour) is rated at an 83 Walk Score value, or "Very Walkable" (*Walkability research*, n.d.).

Qualitative Elements of Walkability

Pedestrian perceptions of comfort and safety are widely accepted as the main qualitative measures by which walkability can be analyzed; however, the specific criteria that make up these measures are complex, interconnected, and difficult to quantify reliably (Landis, Vattikuti, Ottenberg, McLeod, & Guttenplan, 2001). A quantitative calculation based on survey data (as conducted by Landis et al. in 2001) may be an effective way to weight those factors that affect walkability (e.g., lighting, personal safety and security perceptions, visibly interesting surroundings, etc.), but for the scope of this project, these qualitative elements are not weighted.

I established the following set of criteria as those that define the pedestrian experience in Downtown Durham: physical accessibility, general amenities, safety perception, signage, public green space and social gathering space, cultural points of interest, and sustainability. These criteria were selected based on a common-sense rationale of the important considerations for pedestrians (e.g., can one safely cross the street?), as well as the recurring elements of walkability identified in the literature. Specifically, these elements intersected with overarching themes of personal access and physical comfort, visual interest, and safety (McCann & Rynne, 2010; Landis et al, 2001; Tumber, 2012; LIB, n.d.). Ratings of these criteria are qualitative and unweighted, and are based off personal judgement rather than the average perceptions of a group. Visible sustainability elements are not identified as

being crucial to walkability, but are included because of personal interest in the relationship between a sustainable, low-pollution lifestyle and normalized American car culture. Renewable energy systems, bicycle racks, and recycling bins were grouped into the general category “Sustainability”; however, as renewable energy systems and recycling bins were not visible along the route, bicycle racks were the only mapped components of this category.

Information Sharing for Public Engagement

The City of Durham recently began subscribing to the Regional Analysis and Information Sharing (RAIDS) online service of mapping criminal activity city-wide in conjunction with the Durham Police Department (Gronberg, 2015). The interactive service includes more data analysis features, more specific filtering options, and generally more usability than the previous CrimeMapper service (BAIR Analytics, 2015). It also connects subscribers to an alert system for immediate updates. Durham’s move to the RAIDS service is one part of its greater shift towards systematic information sharing that promotes overall community engagement. Because community engagement in the planning process is cited repeatedly as a factor in successful Complete Streets policies (McCann & Rynne, 2010), increasing communication with the city government along such other lines as crime mapping only reinforces those ties.

Organic Transit: Beyond Traditional Transportation Modes

Although walkability is one essential part of the Complete Streets movement, the movement also includes a spectrum of users between pedestrians and car drivers: namely, people using bicycles, buses or other public transportation, or some combination thereof.

Public transportation may decrease reliance on personal cars, but still poses a petroleum-fuel problem. Bicycles use no liquid fuel but can be physically challenging, and their use exposes cyclists to adverse weather and is prohibitive to transporting passengers or cargo. The Downtown Durham-based company Organic Transit, founded in 2009, created the ELF (in essence a reclined bicycle with a solar-powered supplemental motor and a protective shell) to fill this transportation niche between bicycles and cars. The ELF is one of many so-called "velomobiles" which provide more shelter, space, and power than a bicycle while removing the need for liquid fuel, thus expanding the available choices for people whose transportation needs (e.g., caterers, campus police, errands with cargo, and so on) are not met by traditional bicycles (Wojciechowska, 2015). The popularity of the ELF in Durham (although quantitative data are not available, it is common to see enthusiastic ELF owners around the Downtown districts or at the nearby Farmer's Market) also shows it to be a viable alternative to car travel (Organic Transit, n.d.). The ELF, along with other velomobiles, does address concerns about the sustainability of fossil fuel use, but its use is generally restricted to streets with less than 30 mph speed limits. Its cost (standard models start at $5,495) is also prohibitive in comparison to that of a normal bicycle. While the ELF is a relatively new form of transportation that provides an urban car alternative, its use does not address issues of economic access, roadway design, or city density.

Analyzing Urban Spaces: Pedestrian Level of Service (PLOS) Audit

Pedestrian Level of Service (PLOS) is a numerical rating from 1-100 which assesses the walkability of a specific street according to criteria such as sidewalk width and condition, presence of buffer zones (e.g., street parking), and trees along a road (League of Illinois

Bicyclists [LIB], n.d.). PLOS was officially developed under the umbrella of a Multimodal Level of Service (MMLOS), which addresses LOS for transit riders, bicyclists, and pedestrians in addition to vehicular LOS. MMLOS is a recent expansion for the Transportation Research Board, the organization within the U.S. Department of Transportation responsible for setting national street analysis standards through publication of the *Highway Capacity Manual* [HCM] (Huff & Liggett, 2014). The most recent HCM (2010) is the first since 2000 to systematically address street accessibility for non-vehicle users (McCann & Rynne, 2010). Huff and Liggett (2014) admit that the HCM's 2010 PLOS analysis consists of "data-intensive, mathematically involved, multi-stage calculations" which, despite being specific and defensible analyses of the aspects of street design, in general do not account properly for all of the variables that actually determine the average pedestrian's street experience (p.58-60).

According to McCann and Rynne (2010), LOS traditionally is geared towards keeping vehicle traffic flow steady and unimpeded, but that focus on vehicles does not account for other street users. Therefore, in the scoring schema for LOS, LOS A would be free-flowing traffic and LOS E or F would be completely gridlocked. The standardized nature and widespread use of the HCM makes its LOS system (i.e., LOS elements and calculations) the baseline model from which a non-vehicular LOS can be derived. Communities that wish to create a systematic LOS which includes non-vehicle street users often start with the HCM LOS as a guide. A Complete Streets LOS, and more specifically an appropriate *pedestrian* LOS (PLOS), necessarily considers more complex objectives than traffic flow. People traveling in vehicles are literally insulated from those street elements to

which pedestrians are exposed, and so are less affected by changes in that street environment. As illustrated by the case studies presented in *Complete Streets*, PLOS measures vary both in their calculations and their interpretations, as they reflect the specific goals (e.g., streets designed primarily for children walking to school) of the community in which they are implemented. Thus, the criteria, calculations, and scope of PLOS measures are by nature more mutable than traditional LOS measures. McCann and Rynne note that communities which add Complete Streets initiatives most often use them as supplements to the standard vehicle LOS. While Complete Streets supposedly modifies the goals of traditional LOS to include all street users, in practice this translates to streets that are more accessible to other users but still primarily established around vehicular traffic (2010).

McCann and Rynne (2010) explore the PLOS and other Complete Streets measures in specific community case studies; however, the Sustainable Cities Institute (2013) recommends using the online PLOS calculator developed by the League of Illinois Bicyclists (LIB). The LIB calculator is a simple PLOS measure appropriate for preliminary or amateur analysis of a street's suitability for pedestrian use. Only two of its criteria require annual traffic data from the state Department of Transportation (DOT), although more complex PLOS measures, designed for city planners and the like, typically require significantly more traffic data to complete (Huff & Liggett, 2014). As this study was limited by data constraints that a planning professional would not have, the LIB online calculator proved to be the most appropriate method for determining a quantitative PLOS grade for each street section of the outlined walking route (Figure 1).

RESEARCH METHODS

Qualitative Measures: Observation and Documentation

Using the Compass App on an iPhone 5S, I mapped out places along the walking route which fell into the following sub-categories: physical accessibility, safety, pedestrian signage, general amenities, green and community gathering spaces, cultural amenities, and sustainability elements. I then used a Google maps API to visually represent my observations on an electronic interactive map. Google Maps has been used by several Durham organizations and individuals (e.g., Durham Open Spaces and Trails Commission (DOST), Duke University, Durham Bike Co-op, etc.) to create crowd-sourced documents that are easily available and intuitive to use. Google Maps provides a simple, free starting point from which more sophisticated documents can be created, as in the case of the DOST maps, which now have a more streamlined format available. The City of Durham also refers to some public Google Maps in its online list of pedestrian and bicyclist resources. As in the case of those early crowd-sourced documents, my use of Google Maps is intended to provide a starting point from which other people or organizations in Durham can easily view my observations and possibly incorporate them into their work. Because the Downtown Durham landscape is in the midst of change, the simplicity, flexibility, and interactive nature of Google Maps provides an ideal medium for me to record my observations of the following qualitative elements of walkability.

Physical accessibility.

I mapped out points along the route which would present difficulties to people with physical disabilities. Most of these points coincided with construction zones, deteriorated

crosswalks, and/or temporary detours. Other considerations included pedestrian amenities such as benches, shade, water fountains, waste bins, and public restrooms. The main loop of the walking tour consistently took me, an able-bodied person, one to three hours to complete, depending on the number and duration of explorations of interest sites. The overall length of the walking tour was approximately two miles, and the flat terrain of the route was not physically challenging, so I found the main route of the self-guided walking tour quite accessible.

Safety.

I mapped the dark areas of the downtown route first by walking and then by driving the route several times at night, usually around 10PM. Despite my familiarity with the area, the zones I marked on the map consistently presented areas of low visibility, low pedestrian density, or both. The combination of limited sight and isolation had the effect of creating spaces that felt unsafe for me to linger. These zones generally coincided with empty storefronts, dark construction zones, or deserted parking lots with trees. Although the street landscapes varied, I simply marked those places where I would be wary of walking alone after dark. These points are clearly subjective as they rely only on my experience, but their validity as criteria for walkability are supported by Landis et al. (2001), who rate pedestrian comfort as one of the top three criteria affecting walkability. Although Landis et al. focus mainly on pedestrian comfort in relation to vehicle proximity and traffic, personal security is included as a component of pedestrian comfort and thus of walkability (2001).

Pedestrian signage.

I mapped out the points along the route where there was clear signage specifically for pedestrian use. These signs were consistent in their design style, approximately head height, and directed by use of clearly labeled landmarks with simple arrows and measurements in blocks. I needed these signs more than once when first walking the route, despite having a map, so their presence was helpful. Although I only marked the signs on and near the main route itself, pedestrian signage is installed across the Downtown area.

General amenities and green spaces.

I mapped general pedestrian amenities along the walking route. These consisted mainly of public seating (i.e., not including outside seating for businesses) and green space. Public restrooms and water fountains were available at the beginning of the walking route inside the Visitors Center, though not at any other place along the walking route. These general amenities allow for relaxation and mark the gathering points (i.e., spaces adjacent to, not directly within, the walking path) where pedestrians can rest or socialize.

Cultural amenities.

Along the walking route itself there are several bronze markers indicating Durham's Civil Rights history, as well as murals and other public art displays, some of which are additions to the points of interest already marked on the self-guided tour brochure. Preservation Durham offers information on specific historical sites and other cultural places of interest on its website, as do other art and culture centers in Durham (e.g., the Durham Arts Council). I mapped out only those cultural, historical, and artistic elements which caught my attention in the course of walking.

Sustainability elements.

I was especially interested in finding sustainability elements along the route, because they could indicate existing community interest in the reduction of vehicles for more sustainable fuel use. In this context, sustainability elements included renewable energy installations, bins for recycling or composting, and/or other elements that visibly supported alternative transportation methods to cars (e.g., bicycle racks). Although I analyzed walkability, which itself correlates to transportation and sustainable living, I wanted to see if there were any noticeable street elements (e.g., recycling bins, electric charging stations, etc.) that actively promoted sustainability in the public sphere. Beyond the sheer difficulty in identifying the subtler approaches to sustainability (e.g., using energy efficient lightbulbs in streetlights) in the context of walking this route, I was interested to know if there were socially prominent sustainability elements in Durham.

PLOS Methodology and Collection Parameters

The collection methodology for the PLOS was simple, because taking measurements required only counting and measuring to the nearest foot. The equipment used was a 20' tape measure, the Compass App (version 2.6.7) on the iPhone 5S, and a digital camera. Although I walked the route several times, I took PLOS measurements on one day only (March 15, 2015). Also, I divided the route into ten smaller sections, choosing division points based on visible changes in the street layout for greater manageability and precision in calculating the PLOS.

Most parameters for the PLOS (see Table 3) were measurable, but three of the parameters required previously collected traffic data. These parameters were (a) the

percentage of heavy vehicles on the street; (b) the bi-directional traffic volume, measured in average daily traffic (ADT); and (c) the sidewalk conditions, rated from 1 (worst) to 5 (best). The first data category, percentage of heavy vehicle traffic, has not been collected for the central Downtown Durham area due to prohibitive costs (R. Perry [NCDOT], personal communication, April 14, 2015). For this category, I used the given value (2%) provided by the LIB online PLOS calculator. The second category of data, provided by the North Carolina Department of Transportation (NCDOT), is included as annual average daily traffic (AADT) for the year 2013, which is the most recent data available. A map of the AADT data for the main route of the self-guided walking tour is shown in Figure 7.

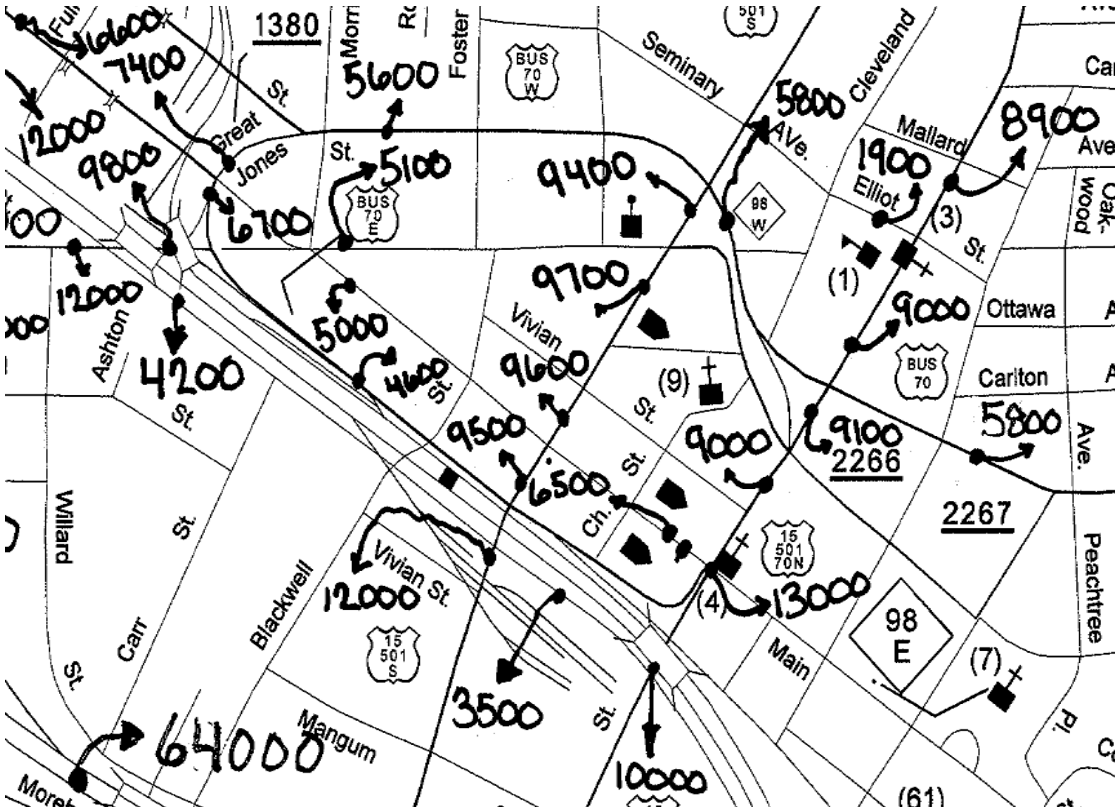

Figure 7. Map of annual average daily traffic (AADT) data (NCDOT, 2013). This figure illustrates the average total number of vehicles (assuming that all vehicles are 2-axle, as the collection method relies on counting axles rather than vehicles) which pass over each specific location over the course of one year (2013).

The third category required a rating system of 1-5 (worst-best) for sidewalk conditions, but Durham uses a system of "good" or "other" as designators for sidewalk conditions (*DurhamWalks! Pedestrian Plan*, 2011, p. 4:3). All sidewalks on the main walking route were rated "good" as of 2011, so I used the value 4 (which equals a "good" rating according to the LIB calculator form) for this category in all PLOS calculations.

FINDINGS

Findings sub-sections are listed here in the order corresponding to the order of sub-sections within the Methodology section and include observed data as shown in each respective Google Map layer. Although each map layer is addressed within a different sub-section, the issues addressed below affect multiple characteristics of walkability. The findings address those characteristics which affect the usability and attractiveness of the Downtown Durham self-guided walking tour.

Physical Accessibility

Most parts of the main route of the self-guided walking tour were accessible to physically disabled or differently-abled people[5], with the exception of a few crosswalks and sidewalk construction detours as marked on the Recommendations layer of the map (Figure 3). These crosswalks did have the correct curb gradations, but the asphalt in the middle of the crosswalk was often severely degraded and uneven, possibly presenting a challenge to wheelchairs or walkers. Although every major crosswalk did have a lighted pedestrian sign, none used any auditory cues. Other accessibility issues included sidewalk or lot construction, which required several detours. Figure 3 shows the location of these elements, but the rapid redevelopment of private properties alongside the street means that the locations of these elements will probably change as Downtown Durham undergoes redevelopment.

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[5] It should be noted here that, as an able-bodied person, it is quite possible that my perception of accessibility will not account for challenges that a handicapped person might have.

Safety

It was my perception that much of the self-guided downtown walking tour was isolated during the day, especially in areas near construction zones or stores out of business. Some especially deserted areas included the Durham Bull Plaza, Parrish Street, and the green space between the Durham Armory and the Carolina Theatre (Figure 8).

The map layer of the dark and/or deserted areas of the walking tour is shown below:

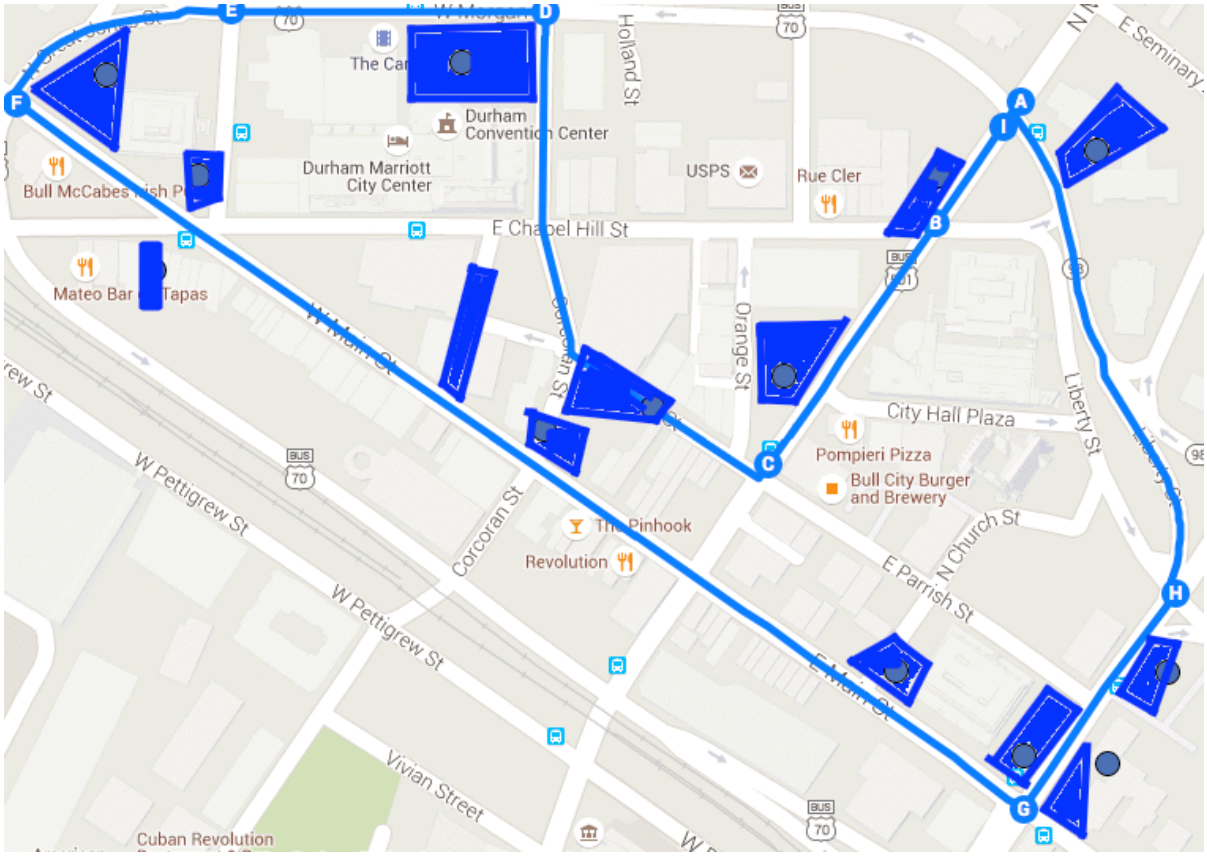

Figure 8. Map layer of the dark, deserted or otherwise unsafe areas of Downtown Durham. This figure illustrates those areas which felt unsafe for me to walk at night.

Figure 9. Photograph of alley marked on Figures 3 and 8 which is a dark pedestrian connection space at night.

I also encountered mild harassment (e.g., catcalls) on the street, even in broad daylight. At night, the places that were darkest and most deserted typically were public green spaces, minor street intersections and alleyways (Figure 9), and parking lots or construction zones which obstructed a clear line of sight. Although the map layer of the dark and unsafe areas was based entirely off of my own perceptions, and was mapped on a slow business night (Monday, when perhaps Saturday would have had more people in the Downtown area), pedestrian perception of safety is a critical part of walkability and one which could use improvement in the current Downtown area.

Pedestrian Signage

Signage for pedestrians used one color scheme, one set of landmarks as reference, city blocks as measurements, and was placed all across the Downtown area. The signage map layer is shown below in Figure 10.

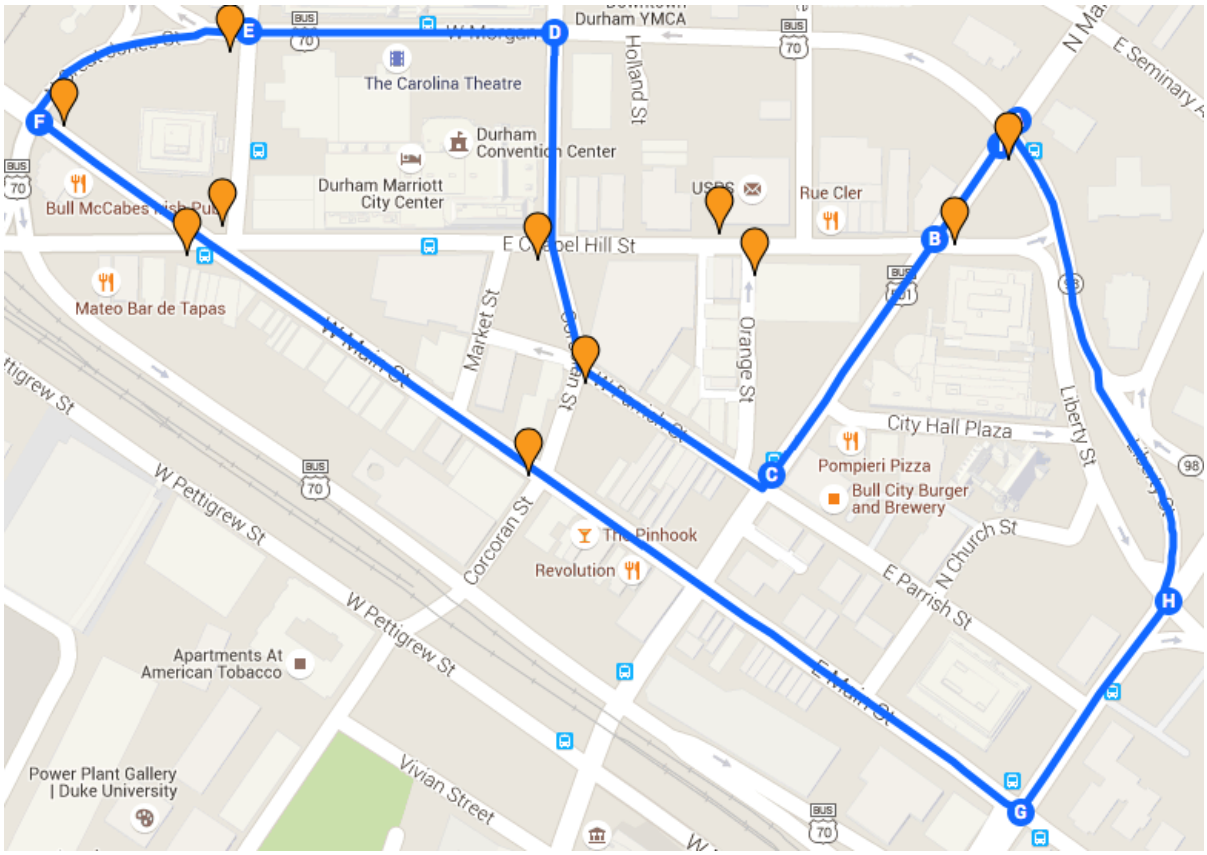

Figure 10. Pedestrian Signage map layer. This map layer shows the location of pedestrian signage (orange markers) encountered when walking the self-guided tour.

Figure 11. Photograph of a typical pedestrian sign in Downtown Durham. This figure illustrates the clarity of signage directions using arrows and landmarks.

This signage is, of course, not the only signage used by pedestrians, but it is designed especially for pedestrian use (Figure 11). The Durham Area Transit Authority (DATA) signage, as marked by blue bus icons in Figure 10, is an especially useful supplement to the pedestrian signs. Note that some segments (in Figure 10, the lower-righthand corner) of the walk do not have pedestrian signage. However, this section of the walking tour is straightforward and contains only one turn at a major intersection. It is entirely possible that there are pedestrian signs along the outer sides of wide, high-traffic roads or intersections (e.g., Great Jones Street). Yet, the walking tour is visibly self-contained within the boundaries of Main Street and the Downtown Loop, so pedestrian signage is not a crucial issue.

General Amenities

General amenities, which include such elements as public seating, trash disposal, and restrooms, are depicted by blue diamond markers on the map layer in Figure 12. Public restrooms and water fountains are available at the Visitors Center, but not anywhere else along the self-guided walking tour. Downtown Durham already has a system of benches, usually with at least one shade tree, along the self-guided walking tour or in nearby quieter side streets. There also seem to be an adequate number of trash cans (~30), though no recycling bins. Public seating and trash cans are concentrated along Main Street's busy intersection with E. Chapel Hill Street and Morris Street, as well as in the CCB Plaza at the intersection of Foster Street, Corcoran Street, and E. Chapel Hill Street.

General amenities also include public green space and spaces (e.g., fountains with seating) that promote socialization. Though most green space was not cohesive (e.g., several concrete planters containing trees rather than a continuous space with soil), all major gathering spaces along the route (e.g., plazas, major bus stops, performance venues, etc.) did have at least some planted areas (Figures 13 and 14). The green markers on the map layer in Figure 12 show public social spaces and green spaces.

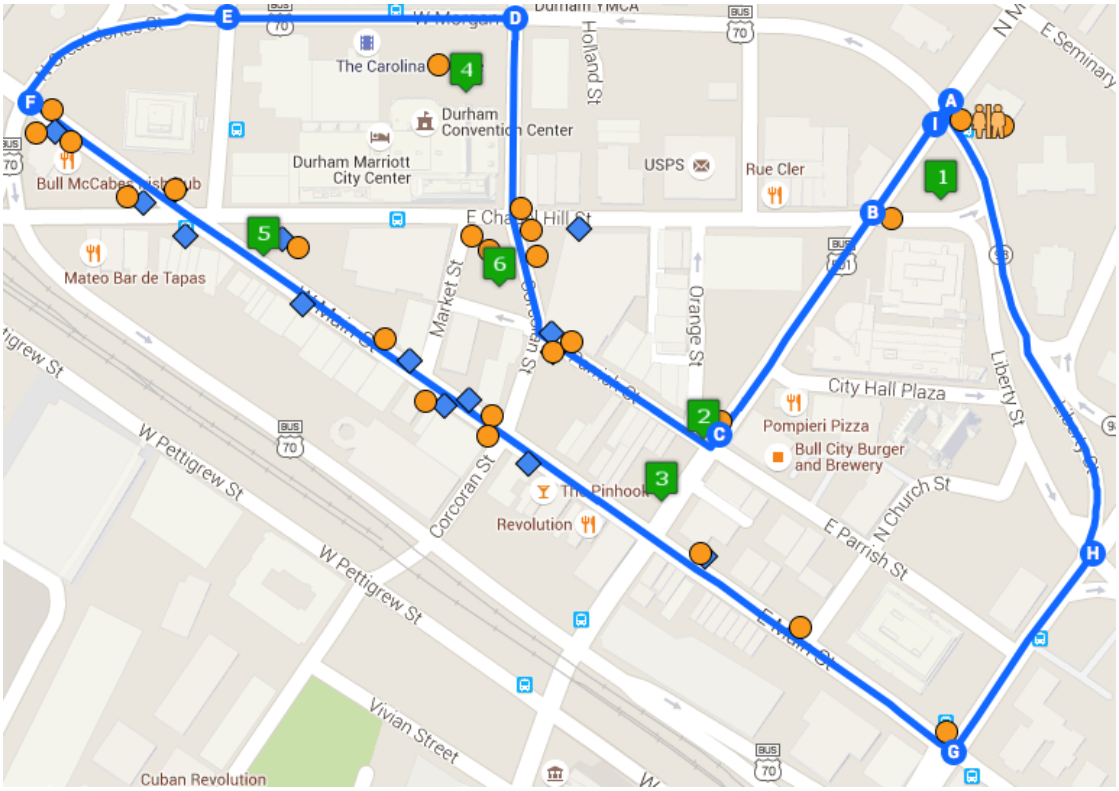

Figure 12. General Amenities map layer including social and green space map layer. This figure illustrates the locations of public seating (blue diamonds), trash cans (orange circles), and restrooms (restroom icon) along the self-guided walking tour. The numbered green squares indicate green and/or gathering spaces which often include general amenities.

Figure 13. Photograph of a green and social gathering space at the corner of E. Chapel Hill Street and W. Main Street in Downtown Durham. This figure illustrates how general amenities, social space, and green space often overlap each other in content and function.

Figure 14. Photograph of green and social space outside of the Carolina Theatre and Convention Center. This figure shows the dual uses of social gathering space and green space.

Cultural Amenities

The brochure published by the DCVB, which contains the map of the self-guided walking tour, already illustrates many of the locations and descriptions of Downtown's historical, artistic, and cultural items. When walking the route, I marked those items which drew my attention while walking on the street, with the result that the map layer of cultural amenities (Figure 15; see also Figures 16 and 17) is quite sparse and supplemental to the thorough survey on DCVB's brochure.

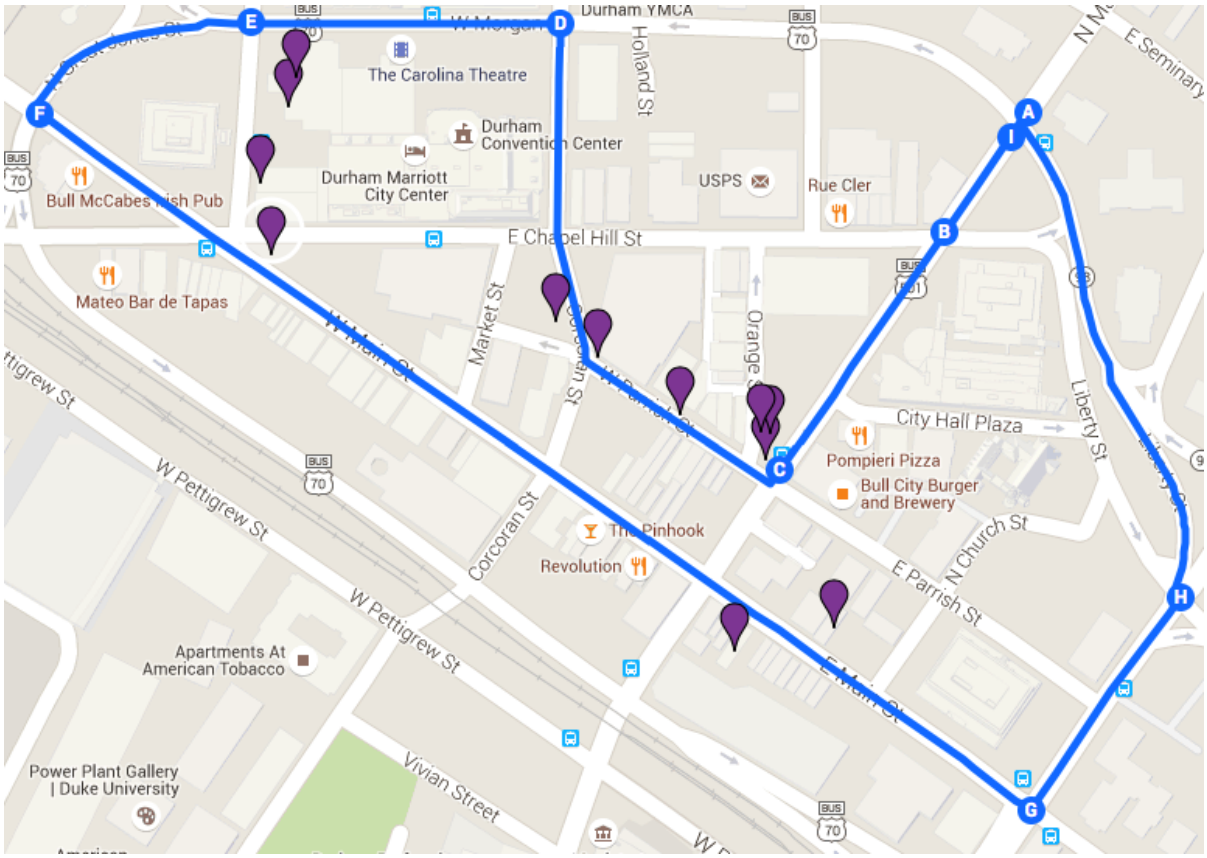

Figure 15. Cultural amenities map layer. This map layer shows those cultural elements along the self-guided walking tour which prompted pedestrians to notice or engage with them, including a Civil Rights series of bronze statues and occasional murals.

Figure 16. Photographs of cultural amenities. The left photograph shows a commemorative bronze plaque in honor of Durham's Civil Rights history outside of the Mechanics and Farmer's Bank on 'Black Wall Street' (i.e., West Parrish Street). The right photograph shows a public art installation in CCB Plaza.

Figure 17. Photograph of Civil Rights mural next to Durham Arts Council. This figure illustrates the ongoing nature of Durham's cultural growth, expressed through a healthy arts scene and research in the city's history.

Sustainability Elements

Since several of Durham's private businesses and organizations advertise their commitment to sustainability (e.g., through Sustain-a-Bull or similar movements), I expected similar public initiatives. Upon walking the route, I saw very few of the above listed sustainability elements. While there were well-maintained trash cans, and ashtrays were usually visible throughout the walking route, there were no outside recycling bins that I noticed. Also, the streets themselves often had cigarette butts, plastic wrappers, and other small trash items strewn about (especially noticeable near bus stops, which had high foot traffic), which indicated a public complacency regarding litter. Though no electric charging stations were visible on the main walking route, a recent initiative by the City Council to provide charging stations for government and public use has already led to the installation of over ten charging stations in or near Downtown Durham (Freid & Carroll, n.d.).

As bicycle accommodation is another part of the Complete Streets movement, and one which demonstrates infrastructure for alternative transportation to petroleum fueled vehicles, bicycle racks on the sidewalks were marked as sustainability elements within the Sustainability layer of the Amenities map. The map layer below shows the bicycle racks along the marked route (Figure 18).[6]

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[6] Although the bicycle racks were present at several points along the main walking route, I saw very few (< 5) racks actually holding bicycles. Further research pursuing the popularity of using those bicycle racks and relevant concerns (e.g., theft, inconvenience, bicycle lanes, shelter, etc.) in the Downtown area may be informative for bicycle initiatives.

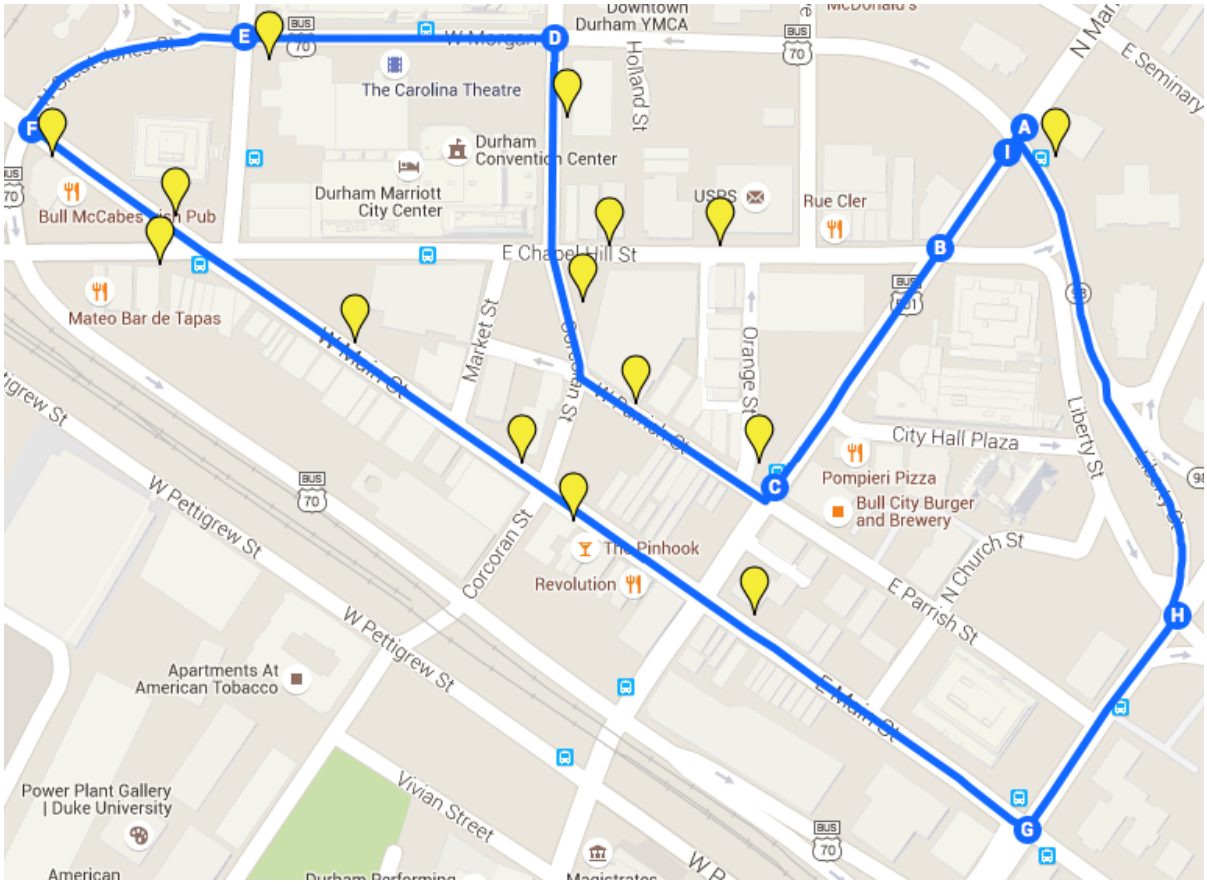

Figure 18. Map layer of bicycle racks (Sustainability layer) from Amenities map. This figure illustrates the locations of street-side bicycle racks along the self-guided walking tour.

Figure 19. Photograph of awning and benches across from City Hall Plaza in Downtown Durham. This figure illustrates the gathering space by several bicycle racks and a busy DATA bus stop, which shows supporting public infrastructure not only for these transportation systems as methods of movement but also as methods of lived experience.

Several organizations in Durham promote bicycle use (e.g., Durham BPAC, Bike Co-op, Open Space and Trails Commission, Triangle Transit, etc.).[7] The City of Durham has also created several pedestrian- and bicyclist-oriented maps freely available on the official city

[7] Duke University's nearby East Campus also has a dedicated bicycle community and numerous bicycle racks, as shown on their public Google Map retrieved from [https://www.google.com/maps/@36.2153096,-81.6767295,15z/data=!4m2!6m1!1sz5GjK25iZkjo.k278Uq-Vk88s]. As that campus is adjacent to and not within Downtown Durham, it is not included in this study.

website as part of the 2011 DurhamWalks! initiative. It is worth noting here that the above organizations and infrastructure (Figure 19) demonstrate support for biking and other sustainable initiatives as lifestyle choices, not just as methods of transportation.

PLOS Findings

The PLOS numerical score for this section of the Downtown Durham walking tour, as calculated by the LIB online calculator, falls within a range that is graded as shown in Table 1. To conduct the PLOS survey, I divided the central loop of the Downtown Durham walking tour into ten segments based on visible changes in the street (e.g., intersections, construction points, etc.) and the AADT data provided. This survey had several complicating factors. First, the online calculation tool uses PLOS model parameters for two to four (2-4) through lanes per direction, assuming a two-way street. However, a majority (six) of the walking tour street sections were one-way streets. In calculating PLOS scores, I noticed that a higher number of through lanes (selecting within the available 1-3 range) corresponded with a lower and therefore better PLOS score. A second complication was the lack of AADT data for two streets (W. Parrish Street and Corcoran Street). Although 2013 data were not publicly available for these street segments, there were 2008 AADT data available for the remaining two street segments, as marked by "**" text (Kimley-Horn and Associates, Inc., 2010, pp. 19-20). Table 1 shows PLOS scoring and Table 2 shows a scoring key of PLOS criteria. Table 3 shows the measurements and final PLOS scores for each section of the route.

Level-of-service	Compatibility Level
A (below 1.50)	Extremely High
B (1.51 - 2.50)	Very High
C (2.51 - 3.50)	Moderately High
D (3.51 - 4.50)	Moderately Low

Table 1. Pedestrian level of service scoring. This table illustrates the ranges of values which indicate different levels of compatibility with an ideal PLOS score, and thus with an extremely walkable street.

PLOS Criteria Key:
Route Segment (A) = Through lanes per direction
B = Width of outside travel lane, to outside stripe (ft.)
C = Paved shoulder, bike lane, marked parking area: outside lane stripe to pavement edge (ft.)
D = Bi-directional Traffic Volume (in ADT)
E = Percentage of road segment with occupied on-street parking (%)
F = Percentage of segment with sidewalks (%)
G = Sidewalk width (ft.)
H = Sidewalk buffer/parkway width (ft.)
I = Buffer/parkway average tree spacing (ft.) (NB: 0 for no trees)
Constants: Posted speed limit (mph): constant value of 25mph on these road segments Percentage of heavy vehicles: no DOT data, using given value (2%) in PLOS calculator Sidewalk condition: no data in correct format, using given value (4) in PLOS calculator

Table 2. Elements for calculating PLOS. This table illustrates the variables which are used to calculate the final PLOS score for each segment, including measured and constant values.

	Route Segment	B	C	D	E	F	G	H	I	Numerical Score	PLOS Score
1	Visitors center to E. Chapel Hill St. 2 lanes, 1 way	10	0	9400	0	100	5	5	0	A1: 2.94 A2: 2.39	C/B
2	to W. Parrish St. 2 lanes, 1 way	12	0	9700	100	100	10	2	0	A1: 2.32 A2: 1.75	B
3	to E. Chapel Hill St./Foster St. corner 1 lane each way	12	7	3200**	92.3	100	10	2	0	1.46	A
4	to W. Morgan St. 1 lane each way	12	6	3500**	57.1	98	8	2	0	1.70	B
5	to N. Great Jones St. 3 lanes, 1 way	15	7	5600	100	100	8	2	0	A1: 1.68 A2: 1.36 A3: 1.25	B/A
6	to W. Main St. 3 lanes, 1 way	15	7	7400	80	100	8	2	0	A1: 1.96 A2: 1.53 A3: 1.39	B/A
7	to Corcoran St./E. Main St. 1 lane each way	10	7	5000	100	100	9	8	25	1.18	A
8	to N. Roxboro St. 1 lane each way	10	7	6500	94.1	100	8	8	25	1.38	A
9	to Liberty St. 5 lanes, 1 way	12	0	9000	0	100	10	2	0	A1: 2.69 A2: 2.17 A3: 2.00	C/B
10	to Visitors Center 2 lanes, 1 way	12	0	5800	0	100	10	2	0	A1: 2.32 A2: 1.99	B

Table 3. PLOS scores for each segment of the walking tour. This table illustrates the calculated PLOS score for each segment of the main route of the self-guided walking tour, and lists the numerical scores for one-way segments in order of selected number of two-way through lanes.

The following photographs compare the street section with the lowest and best PLOS score (PLOS score 1.18, 7th section) with the highest and worst PLOS score (PLOS score 2.94, 1st section) for a visual representation of walkability (Figures 20 through 23).

Figure 20. Street view photograph of W. Main Street, Durham at the intersection of E. Chapel Hill Street, depicting an 'Extremely High' level of walkability according to PLOS calculations. Photograph retrieved from Google Maps, July 20, 2015.

Figure 21. Photograph of sidewalk shown in Figure 20. This figure depicts tree buffers, wide sidewalks, street lighting and visually appealing elements which support its favorable PLOS score.

Figure 22. Street view photograph of the first PLOS section: N. Mangum Street, Durham at the intersection of W. Morgan Street. This photograph, retrieved from Google Maps, shows the street section with the highest and worst PLOS score.

Figure 23. Photographs of PLOS Section 1. The left photograph shows the deteriorated condition of the crosswalk at the corner of W. Morgan Street and N. Mangum Street. The right photograph shows the sidewalk section used to calculate the worst PLOS score.

The final PLOS scores ranged from 1.18 to 2.94, with 1.75 as the median value. For the one-way streets, I first marked the number of through lanes as the total number of lanes (e.g., the one-way, two lane street segment from the Visitors Center to the corner of E. Chapel Hill Street was marked as having two through lanes in each direction). I also marked the other choice for one-way streets by selecting the total number of lanes disregarding direction (e.g., the same street segment in the example above was marked as having one through lane per direction for a total of two lanes in the street). These results are listed in the Numerical Score column, with the marked trend that more through lanes per direction corresponds to a better PLOS score. Three segments have a definite 'A' or 'B' score which respectively correspond to an Extremely High or Very High compatibility level with PLOS standards. Two other segments could arguably also be scored in the 'A' range, meaning that most (8/10) of the street segments would not, according to the PLOS model, require changes. The final two segments could be scored 'C' or 'B'. Recommendations for improving the PLOS scores for those two segments are below, along with recommendations to improve the qualitative elements of the self-guided walking tour.

Recommendations for Enhancing the Walking Tours

The two segments of the walking tour which could be graded in the 'C' range for the PLOS had the following characteristics in common: one-way streets with multiple lanes, high traffic (9000+ AADT) compared to most of the other segments, no shoulder and small buffer zones. As both sections also had hardly any shade, one suggestion to improve their walkability would be to widen the buffer zones and install a series of tree planters. Another suggestion would be to convert one lane into a bicycle lane, which would also serve as a

buffer between the sidewalk and the street. These or similar modifications would help mitigate street issues of safety, noise, and heat, and would increase the appeal of the street segments to pedestrians.

In terms of physical access, the points of general improvement that could be implemented are (a) marking pedestrian direction signs in bolder colors, or otherwise changing the display orientation to increase visibility and thus the ease of navigating the Downtown area; (b) increasing the amount of trees, awnings, or other structures over sidewalks to provide more shelter from the heat and brightness of the sun or from inclement weather; and (c) repaving the crosswalks that need repair. For the first category, the amount of signage is sufficient for navigation, and multiple signs are now consolidated along one pole as McCann and Rynne (2010) recommend (Figure 24). The issues I encountered with signage were due to temporary detours and construction signage, which should resolve themselves upon completion of construction.

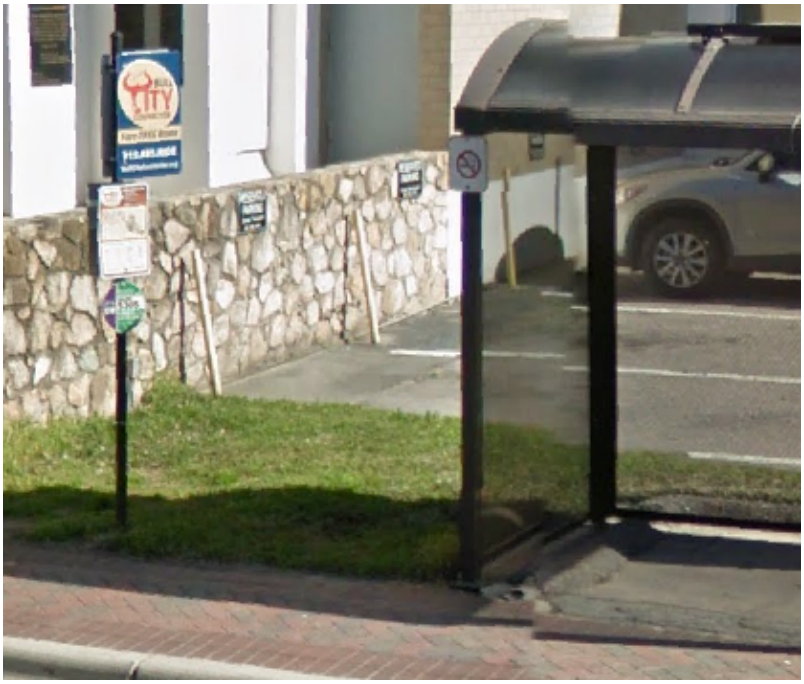

Figure 24. Street view of signage by DATA bus stop along E. Main Street, Durham, NC. Retrieved from Google Maps. This figure illustrates the consolidated, orderly signage that is now generally present throughout Downtown Durham.

The second suggestion, increasing street elements to minimize exposure to adverse weather, could be addressed at several points. A series of awnings or continuous awning across the dense business section by the intersection of Main Street and E. Chapel Hill Street would provide more consistent protection for pedestrians. Also, the parking lot at that intersection and the one by Corcoran Street would benefit doubly from photovoltaic canopies, which reduce both glare and the heat island effect. Such canopies would also be a public statement of support (especially as the office for DDI, a driving force behind Downtown economic redevelopment, is located at that intersection) for renewable energy, which ties in with Durham's emphasis on sustainability (Figures 25 and 26).

Figure 25. Street view of intersection by DDI. This figure illustrates the current parking lot and location of trees, as well as the rows of parking spaces where photovoltaic canopies could be installed.

Figure 26. Photograph of parking lot at the corner of N. Church Street and Main Street in Downtown Durham. This photograph illustrates the current parking lot and its potential for photovoltaic canopies to reduce the heat island effect.

The third suggestion, repaving of crosswalks and repair of sidewalks, has already been addressed to some extent in the City of Durham's 2011 update to the 2006 *Downtown Durham Master Plan* document. An addendum on the website lists current sites for sidewalk repair, which are set to be completed within the next two (2) years (*Downtown Durham master plan*, 2011). A visual map of those repair sites, as well as a clearly labeled link for residents to submit repair sites for consideration, would more clearly illustrate the current state of sidewalks with projected repairs.

In terms of safety, I noticed that most of the dark or deserted areas that felt unsafe coincided with construction zones. If the Downtown area continues to experience the redevelopment and investment that DDI and the City are working to promote, and if more businesses lease currently empty storefronts, the combination of added street lighting and economic density should alleviate pedestrian safety concerns in most if not all of these areas. Routine analysis of areas perceived as dark and unsafe might be especially useful when coupled with projected construction schedules, as it would give a visual presentation of those areas that need additional street lighting at night. Publicly funded temporary lighting could be installed for the project duration, or city ordinances could be modified to require night lighting at current construction zones to increase visibility and safety.

In terms of proximity to cultural and social points of interest, adding directions to existing interest points to the walking tour guide, especially those that are not immediately apparent from the sidewalk (e.g., the Carrack, which is only accessible through a private business and up a staircase), would benefit pedestrians by encouraging exploration and socialization beyond the sidewalk.

As mentioned above, a photovoltaic canopy over existing car parks would actively promote a commitment to sustainability as well as generate power. Also, adding recycling bins to the current trash can locations might improve sustainable waste disposal. Other actions, such as city incentives for LEED certified buildings and higher density zoning, would further promote low fuel usage within a culture of sustainable living. Currently, the City of Durham's Sustainability Office does offer several incentives to homeowners and commuters to reduce their energy use, and also provides links to current requirements for energy efficiency that address both policy (e.g., restrictions on idling City vehicles) and building standards (e.g., high environmental standards, including LEED certification, for new lot developments) for Durham (Freid & Carroll, n.d.). This site gives a thorough overview of those sustainability elements and initiatives that are present but not obvious from the street; however, advertising those existing city initiatives and expanding their scope (e.g., installing an electric vehicle charging station at the busy intersection of E. Chapel Hill Street and Main Street) would increase their visibility and more firmly establish Durham's identity as a sustainable city.

Discussion and Conclusions

The current characteristics of the Main Route of the Downtown Durham self-guided walking tour make for a very walkable environment and are already promoting a systematic reduction in fuel vehicle use. The previously identified points on the Amenities map show which spaces might benefit from changes to increase walkability, but the amount of ongoing construction in the City Center district also indicates that Durham is currently experiencing a high amount of growth and change in any case. This growth rate naturally limits the

timeframe for which the specific recommendations of this study will be applicable. Yet, as in the case of previous Google Maps documents, the interactive document and resulting study may prove a useful blueprint to someone creating a more sophisticated and inclusive analysis of Downtown Durham's walkability. The City of Durham and its private partners have the opportunity looking forward to implement Complete Streets strategies with developing properties and, in doing so, to tie together a well-lit, physically accessible, interconnected network of sidewalks in the Downtown area. Additional changes to increase the visibility of pedestrian signage, the presence of public gathering and green spaces, and sidewalk buffers and tree shading would only add to the pedestrian appeal of the self-guided walking tour. While the selected self-guided walking route is one published by Durham's Tourism Board and so designed for tourist use, it can still serve as an example of a highly walkable area for other parts of Downtown and the surrounding Durham municipality to mimic. By increasing its walkability, Downtown Durham can correspondingly decrease its reliance on automobiles and increase its environmental sustainability along with economic stability and high social capital to become a more livable, sustainable city.

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