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Modality: Mobility and form in Chicago's built environment

Cities and metropolitan areas are home to over 80% of the United States' population today, and this proportion has increased steadily over time since the country's inception. Yet contemporary American cities are not designed for their inhabitants. With the advent and the proliferation of the personal automobile, American cities have shifted form, assuming a much more car-dominated scape. One of the great casualties of this shift has been the freedom and mobility of the individual. Gone are the days of people walking and biking to work or school, to the store, or to friends' houses; because of the vast distances, low densities, and sheer quantities of vehicles moving at high speeds along wide streets, urban environments are far too impractical for traditional forms of mobility like walking and biking.

Though the car-ification of cities has manifested across American cities, the nuances by which city form has adapted to the automobile are variegated. Each American city took to the car at different stages in their developments, and so the impact of city form among individuals has changed in different ways across space. The city of Chicago presents a unique case of a city with a rigid orthogonal grid system on a flat plain that largely developed prior to the proliferation of cars as a primary method of transportation in cities. This paper seeks to interrogate the "modality" of Chicago – that is, the ways in which Chicago's unique urban form contributes to, or makes difficult, the lived experiences of individuals, particularly in the ways of navigation, exploration, and access. These themes are applicable at various scales in the city, such as the holistic city, the enclosed neighborhood cell, and the individual street or corridor. Ultimately, such an analysis attempts to present a "toolbox" of concepts and phenomena relating to

Chicago's built environment idiosyncrasies that helps to explain how that environment shapes the lived experiences of Chicagoans overall.

Literature review

Kevin Lynch, in his book *The Image of the City* (1960), writes about the "legibility" of the city, which he defines as "the ease with which its parts can be recognized and can be organized into a coherent pattern." He expands on the legibility concept, framing the legible city as a tool that helps with navigation, incites personal growth and even "heighten[s] the depth and intensity of the human experience". Chicago is arguably an extremely legible city, in Lynchian terms, on the grounds of its well-defined orthogonal, or grid, street pattern.

Additional research corroborates Lynch's ideas of city legibility. Moar, Hamer, and Woods (1983) investigated the impact of what they call a "grid schema", or a framework people use to remember complex street grids. They hypothesized that individuals would reproduce mental maps of messy street networks by representing them in a more-or-less grid structure: They would remember curved roads as straight, remember roads as parallel that have similar but not parallel orientations, etc. Their results supported the idea that we mentally simplify complex urban street network patterns into orthogonal representations. This supports Lynch's notion that highly legible or patterned cities are easier to mentally reproduce accurately than complex city street patterns. Moreover, the idea of the "grid schema" is reminiscent of Chicago's street grid, in which most streets traverse across the entire city and streets intersect with each other at 90 degree angles.

However, Chicago's grid is especially unique in that it is also almost perfectly aligned with the cardinal directions. The aspect of cardinality is important in city navigation. In an

experiment to assess how street cardinality impacts individuals' spatial awareness, Montello (1991) showed that individuals located on orthogonal or gridded streets in a neighborhood were more easily able to point to nonvisible features or identify the cardinal directions in comparison to individuals located on streets not in alignment with the street grid in that same neighborhood. This supports the idea that in Chicago, with its vast, cardinal grid system, individuals on that grid are more aware of the direction they are facing or moving, but individuals on streets that cut through the grid, such as Milwaukee or Ogden Avenues, may be more confused.

One oversight of the notion of navigability or legibility in cities is the lack of emphasis on accessibility. Cities can be extremely legible and navigable, but in terms of mobility, do they enforce certain travel behaviors or transportation modes? A city can have a fantastic street grid that makes navigation easy, but the transportation corridors may be only accessible for high-speed motor travel. Thus, in seeking to answer how urban form shapes people's experience of the city, considering alternatives to the car is paramount. Research points to links between urban form and perceptions of walkability; Oreskovic et al. (2014) found that the presence of ground-floor windows and street focal points enhanced perceived walkability. Giles-Corti et al. (2009) also found strong links between aspects of form like density, mixed uses, and recreational facilities, and physical activity, especially among older children. They also found that factors like traffic and motor vehicle usage have negative impacts on children's mobility (Giles-Corti et al., 2009). In fact, there is a large body of research concerning urban design's impact on children's mobility: Carlson et al. (2015) show positive associations between intersection density, residential density, and neighborhood walkability, and walking and biking among youth. Curtis et al. (2015) also connects denser built environments with active travel among children, and

Villanueva et al. (2016) connects child development to green spaces, nature, traffic exposure, and housing density.

Altogether, this research corroborates the idea that a city is more accessible – that is, its form encourages more transportation modalities – if it is denser and more walkable. Chicago validates this idea as well: The city has plenty of walkable neighborhoods with ubiquitous sidewalks, narrower streets, and denser built forms which generally means slower vehicle traffic and heightened access to more spaces, businesses, and city functions for those on foot. Moreover, Chicago accommodates many different types of transportation in addition to walking; it has a well-integrated transit system, its neighborhoods are fairly safe for biking, and drivers are abundant. In theory, Chicago should be a great city for active travel among children.

On the other side of the mobility coin is the impact of mobility on the development of the child. Rissotto and Tonucci (2002) show that children who navigate to school on their own, e.g. through walking, are better able to map their route. Maiss & Handy (2011) show that children who primarily travel by bicycle are better able to recall geographic details of their communities than children who travel passively, e.g. as a passenger in a car, and that children who bike develop more spatial awareness at a faster rate than children who don't. Synthesizing each of these bodies of research, if denser built environments that integrate green space foster active travel among children, and if active travel fosters cognitive development and spatial awareness among children, it follows that denser built environments improve children's spatial awareness. Thus, we have another interpretation on city form as a tool: Whereas Lynch (1960) argues for legibility as a means of security, familiarity, and personal growth, recent research makes the case for accessibility of the built environment as a means of physical health, cognitive development, and spatial awareness.

It seems like Lynch and the more recent bodies of research are missing a connection. Lynch is focused on the macro-level, overarching logic structures of the city and how those structures trickle down to improve the lives of their benefactors. The current discourse on mobility focuses on general concepts of form at a hyper-localized level and how those concepts nurture individuals from the ground up. In this sense, Lynch views the city form as much more of a corrective tool for navigation, whereas mobility scholars might argue that individuals don't need such overarching tools if their local environments are conducive to safe exploration which empowers people (children) to improve their navigation. Lynch does admit that too much legibility can be too prescriptive, conceding "an environment which is ordered in precise and final detail may inhibit new patterns of activity" (1960).

Chicago thus presents a case of a city with a built form that should be easily navigable and that nurtures cognitive development among its young population. However, Lynch's theories lack nuance as to *who* is navigating. Additionally, these recent children's mobility studies are mostly limited in scope to regular trips taken by children (e.g. to and from school). More research investigating children's (or individuals') spatial awareness in more exploratory settings rather than settings they are already familiar with would be useful for assessing whether Chicago's built environment is genuinely easier to learn, remember, and navigate, as Lynch might argue. Moreover, while there is an abundance of literature linking modalities of transportation and urban form, there is not much discourse on how urban form at different scales impacts mobility. Much of the research is on a broad, general scale, linking general concepts of form like density or orthogonality to increased mobility. Toward this end, a closer examination of specific aspects of the built form of Chicago at different scales and how that form influences movement of individuals can be helpful.

Analysis and discussion

The modality of Chicago in relation to its urban form – how Chicago's built environment shapes how people experience a place – manifests at different scales. At the highest scale, the city's extreme orthogonality and orientation along Lake Michigan shape form, and thus city modality all throughout the city. At the medium scale of the neighborhood "cell", wide and dangerous roads carve up the city into cubicles that act as self-enclosed communities that mediate between the overarching structures of holistic city form and the granular structures within them. Small-scale forms like the street and its structure influence how individuals experience the city on a quotidian basis. In Chicago, the larger scale a form, the greater influence it has on the forms smaller than it in scale.

Large scale modalities

The urban form of Chicago must be understood from a top-down perspective. There are two key factors which shape Chicago's form at the largest scale: Holistic orthogonality, and the city's adjacency to Lake Michigan. Each of these top-down factors are integral to the quotidian experience of Chicago's urban form. A vast majority of the city is aligned to an almost perfectly north to south, east to west street grid. Admiring Chicago from a bird's eye perspective, the city resembles an almost perfect spreadsheet that spans a vast and flat plain until suddenly breaking along the shore of the lake. Each of these factors combine to create a "logic" of mobility which determines how Chicagoans negotiate their built environments at smaller scales.

Chicago exemplifies possibly the most perfectly realized extreme of orthogonality of any city of its size. The city grid is almost perfectly aligned to the four cardinal directions, and it is perfectly spaced so that major grid streets are exactly 0.5 miles apart. Because it is aligned to the

compass, different areas in the city have distinct identities in relation to which cardinal direction they lie relative to the Loop: Most prominently, the north side, west side, and south side. These spatial properties seep into the identities of the city's residents; for example, Chicagoans view themselves as "north siders" or "south siders". Furthermore, Chicago's street and block numbering system takes advantage of this cardinality. The system is so well integrated to the point that individuals who are well-informed as to how the block system works would be able to easily identify generally where in the city someplace is located, and roughly how far away from downtown it is in miles, only given the cross streets' block numbers. In Chicago, major streets increase in block numbers in iterations of 400 (they occur every four blocks), with north-south streets diverging from Madison Street and east-west streets diverging from State Street right in the center of the Loop. Increments of 800 in block number represent one mile. Someone standing at the intersection of Fullerton Avenue and California Avenue would see they are at the intersection of the 2400 N block and the 2800 W block, and thus they would be exactly 3 miles north and 3.5 miles west of the heart of the city. In a vacuum, Chicago is perfect for navigation; if someone knows the block numbers of their destination's cross streets, without a map, they would only need to travel far enough north or south, and east or west, until they reach their destination.

Moreover, streets are straight and the topography is flat. Most individuals navigating through the city, whether by vehicle, bike, or on foot, are traveling in straight lines on straight paths, only changing direction at intersections, and only changing in elevation at bridges or over- or underpasses. This general homogeneity in direction and elevation acts as a great equalizer that makes wayfinding incredibly simple and preserves sense of direction. The city seems aware of its orthogonal advantages, integrating compasses into the sidewalks at the entrances and exits of

underground CTA stations to re-orient transit riders emerging from the labyrinths which may deprive them of their sense of direction. This orthogonal logic is not entirely sacrosanct, however; there are several streets, physical features, or rail lines that perforate the grid at an angle, and there are areas of the city where the perfection of the grid is compromised. But these spaces are exceptions to the rule and are usually contained within and subsumed by the larger overarching grid structure.

In addition to the orthogonal system, Chicago's adjacency to Lake Michigan also orients residents and shapes the modalities by which they navigate, explore, and access the city. Directionally-challenged Chicagoans know that, no matter where in the city they are, Lake Michigan is to their east. The lake acts as a spatial reference point that contextualizes locations of places. For example, a place can be close to, or far from, the lake, and a place's proximity to the lake gives residents a general idea as to the urban form of that place. Generally, the lake shapes form by serving as an edge along which development clusters, so there are often tall apartment or condo buildings along the lake no matter how far north or south. The heights of buildings will increase closer to the lake, and then buildings immediately cease. Standing at a distance, even if the lake is not visible, it is often easy to identify where the bounds of the lake are just by judging where the tall buildings stop. The lake always has a presence that is reflected in Chicago's urban form; even though individuals may be far from its shores, it leaves its implicit mark on the city's built environment.

Mid-scale modality

Both orthogonality and the Lake leave strong marks on Chicago's urban form at the medium-scale level of the "cell". As aforementioned, Chicago is carved up into a grid by major streets, with its birds-eye form resembling a matrix or spreadsheet. Though Chicago's actual

neighborhood delineations are usually comprised of multiples of these “cells” which are often split by intervening features like expressways, rail lines, and water bodies, each “cell” of the spreadsheet exhibits its own semi-self-sufficient ecosystem. The “cell” enclosed by Fullerton Avenue to the north, Armitage Avenue to the south, Kedzie Boulevard to the east, and Central Park Avenue to the west is a good example. Its periphery is demarcated by higher-capacity streets that are wide and form large intersections with traffic signals. Along these corridors are commercial functions, restaurants, convenience stores; effectively, residents within the cell must venture out to its periphery to do commerce. There are also two moderate-capacity streets that run through the center of the cell: Kimball Avenue and Palmer Street, at the intersection of which lie an ethnic grocery store and a restaurant. Most everyday needs are accessible along these peripheries or at the intersection of the two central corridors, meaning residents inside the cell shouldn’t need to cross the “moat” enclosing the cell. However, many cells lack higher-order functions like schools. Though smaller-scale (e.g. elementary) schools or religious functions are common among individual cells, they are often distributed in ways such that residents of cells must leave their cell to fulfill these needs. But because of the tendency of the major grid streets to be wider and carry more vehicle traffic moving at higher speeds, stepping outside one’s cell becomes a significant leap, especially for young people or individuals with mobility challenges. Often the density of functions in each cell is just not high enough to accommodate every essential function, so leaving one’s cell is a regular occurrence.

This changes closer to Lake Michigan. Closer to the Lake, cells become scrunched up, with many more perforating streets cutting through the grid, more higher-capacity streets running parallel to the lakeshore, and the main grid streets losing their “moat” tendencies as a result of increased housing and intersection density. Traffic moves slower and there are more destinations

within walking distance; the density of functions accommodates more essential functions and whether one leaves their "cell" is often unclear. This is especially the case on the north side. Thus, functionally, "cells" closer to the lakeshore are more accessible at the minor expense of navigability; it's more possible for individuals in these cells to fulfill their necessary quotidian demands, though the increased abandonment of grid principles can be disorienting. Individuals may not be as easily able to point in cardinal directions. However, because these "cells" are proximate to the Lake (which is always to the east), they and their enclosing boundaries are often oriented perpendicular or parallel to it, and modalities of navigation are often in terms of relative location to the Lake or the parks lining its shores.

Small scale modality

At the smallest scale, the street is the mode by which Chicagoans experience their shared built environment on the most quotidian basis. Ventures into the city start and end with the local street. As aforementioned, most residential streets in the city are orthogonal to the overarching city grid, making spatial awareness and direction (theoretically) easy for residents. But the localized built forms on Chicago streets are varied, and the different hierarchical types of streets impose different modal logics on individuals living along them.

For mobility-modality, streets of interest are those along which people are intended (by planners and designers) to reside. Expressways are effectively disconnected from the urban fabric of the city; drivers on the high-speed motorways don't have to interface with other types of mobility, and often these roads in Chicago are physically elevated or sunken from the rest of the street grid. These roads play with different rules and logics of mobility; only driving is allowed, so granular analysis on mobility nuances is impossible. For all other streets, the hierarchy of street types is closely related to the scale of movement – and thus the nuances of

mobility – they accommodate. However, across residential street types, there are commonalities; most notably, almost every street type in Chicago contains sidewalks which separate street users modally. This design essentially proclaims that pedestrians have their own designated space which is separate from drivers and cyclists. In almost every case, Chicagoans leaving their place of residence on foot or by bike interface with a sidewalk before having to interface with any non-pedestrian-oriented infrastructure.

In terms of area taken up in the city, the residential street is the most common street interface. These are the one-way streets that crisscross within the city's spreadsheet cells and funnel traffic to the major grid streets. These streets are often narrow and contain traffic-calming measures like speed bumps, discouraging dangerous, high-speed driving. Structures along these streets are often fronted by gates, many of which resemble one another, which provide a gentle but firm separation between property and the public right-of-way. There is a sense of comfort and security along these streets; each individual structure is secure and private, there is no high-speed vehicle travel, streets are narrow, and buildings are enveloping rather than stifling. These streets often accommodate neighborhood gatherings like block parties and serve as flexible spaces. Enabling the form of the residential street is the alleyway, which places the unsavory public functions of the street (like garbage collection, electric utilities) out of view.

Though driving on both residential streets and alleys is clearly intended to be secondary, their forms do not reject any modality of mobility but are often suggestive to walking and biking. However, as aforementioned, the further a city cell is from the Lake, the less access on foot or bike its inhabitants are likely to have to sufficient destinations and quality destinations within that cell. In this case, residents must navigate the patchwork blanket of residential streets to their nearest major grid street to cross the "moat", which is often only safely done at a signaled

intersection. Alleys are more accessible to foot and bicycle traffic than residential streets; they are narrower, have lower speeds, and are less trafficked by cars. However, they are less inviting, with surfaces often in poor condition, and the blank walls of garage doors offer little in terms of visual interest. Emphasis is on function over form here. Thus, biking on streets is often much more comfortable, even if bikes must share space with vehicles moving at higher speeds.

One upside to this patchwork residential street structure is the potential for contained exploration. Any uncompromised cell can be divided into as many as four blocks or eight half-blocks along each side of the cell. This makes for 32 sub-cellular block units that offer any variety of permutations of walking routes within the cell. However, this runs its course after enough pedestrian excursions, constraining explorability.

In opposition to the residential streets are the major grid streets and the grid-defying diagonals that perforate the grid. Along these streets there are often denser forms of housing like five-over-one apartment structures. Individuals living along these corridors often exhibit axial movement patterns over cellular, as they don't experience the same centrifugal force that those who live inside the cells do. They can move laterally along the grid or diagonal to fulfill their quotidian needs. This is amplified by the presence of form-based interventions that encourage biking, such as curb-protected or separated bicycle lanes. However, in the absence of these interventions, major gridways become stressful to navigate for cyclists, who become inconveniences for drivers. Where for residential streets, no mode is expressly forbidden but driving is discouraged, for gridways it is biking that is discouraged but not forbidden. The key difference is that residential streets are still accessible to vehicle travel, albeit at slower speeds, whereas gridways in absence of form-based interventions are hostile to bicycle travel. Major grid streets are thus holistically less accessible than residential streets.

Conclusion

Chicago presents a case of a city whose built environment uniquely shapes the modalities of movement among its inhabitants. The city's unwavering dedication to orthogonality and cardinality, its orientation along Lake Michigan, and its smaller-scale divisions of form like its "cells" and the character of its individual streets of various types contribute to a very conditional mobility. One's modal experience of Chicago is indebted to the relative situation of one's place of residence to the overarching grid structure and the Lake – and within that overarching framework, the relative situation within a cell or along its borders. Regardless of this, these macro-level frameworks of form offer Chicagoans an unparalleled navigation system that encourage spatial consciousness. Altogether, within the "toolbox" of Chicago's modality of urban form, ideas of orthogonality, cardinality, orientation, hierarchy, and the self-containing "cell" are of importance. Future analyses with more attention to shared forms of transportation, and more emphasis on the multiscalarity of different concepts of urban form would be beneficial.

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