A Model to Understand Urban Resistance to Change: Structural Inertia

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1. INTRODUCTION

We contend that a potentially significant, yet little investigated factor in understanding urban morphogenesis is what we have termed structural inertia—the tendency of an urban area to resist change due to its existing physical, economic, social, and cultural fabric. A potentially significant, yet little investigated factor in understanding urban morphogenesis is structural inertia—the tendency of an urban area to resist change due to its existing physical, economic, social, and cultural fabric. In the early 1970s, the geographer Richard Morrill argued that the most crucial influence on the future location of people and activities is their current location. The immense investment in built form and human resources in the existing urban environment fundamentally resists change. Further, the stabilizing elements in the physical environment, including buildings, utilities, roads, and land ownership, decay slowly. Social and cultural cement, such as urban self-image and our sense of neighborhood, also binds our society together. Economically and psychologically, the individual's investment in her home, her business, and her associations tends to render her immobile. Explaining the resilience we observe in cities compels us to understand structural inertia. For example, knowledge of inertial forces in Detroit could aid in explaining why the city persists even though 90% of its housing stock has fallen below the cost of building anew. This paper will present a new model to help investigate and predict the persistence of economically or physically devastated cities such as Detroit and New Orleans, as well as the normal urban growth patterns we see around us every day. Starting with the notions of reproducibility and inertia in the 1984 work of the organizational ecologists Hannan and Freeman, we will develop a theoretical model for understanding the structural inertia of cities. The ultimate step in developing this model will be to operationalize it in the study of specific urban settings in North America.

The purpose of this ongoing research is first to introduce, and then model the concept of structural inertia to help urban researchers, designers, and planners understand and predict the persistence of economically or physically devastated cities such as Detroit and New Orleans; as well as the normal urban growth patterns that we see around us every day. We developed our model construct by first reviewing recent literature on urban morphology and processes that appear to indicate inertial forces at work (see Section 2). Second, we identified and synthesized urban characteristics into a diagram (see Figure 2) and matrix (see Appendix A) that relate both cited examples of inertial factors as well as several moderating variables. Third, we looked to the 1984 work of the organizational ecologists Hannan and Freeman to find precedents in their notions of reproducibility and structural inertia (see Section 3.1 and Figure 4). Fourth, we developed a theoretical model for understanding the mechanism of urban and suburban structural inertia (see

Section 3.2 and Figure 4). Finally, we conclude by indicating possible steps to operationalize our model in the study of real-world urban settings.

2. INERTIAL FACTORS

The following four subsections are a summary of urban factors that appear to correlate with urban structural inertia. Although not exhaustive, the factors presented (see also Figure 2 and Appendix A) are a reasonably robust proposition upon which to formulate our model. The following text sections introduce each category of inertial factors with a brief review of their context, meaning, and citations. The factors and diagram presented in Figure 2 are then incorporated into the model construct introduced in Section 3.2.

2.1 POLITICAL/GOVERNMENTAL/LEGAL: INDIVIDUAL AND COMBINED EFFECTS OF GOVERNMENT ACTION AND INACTION

One of the least observable, yet most powerful factors of inertia in the structure of any North American city is the fee-simple ownership of private property. Campanella (2006, p. 142) notes that this system of transferring and owning property has created a means of organizing space that is virtually indestructible. Campanella asserts: "even if a city is turned into nuclear ash, property lines can be recreated if the legal documents still exist." Kevin Lynch (1972, pp. 3-4; Campanella, 2005, p. 346) pointed out that following the great fire of London in 1666, there were no complete maps or precise title deeds, no long term credit or insurance, and properties were held under a "complicated system of free-holds, leases, and subleases." Yet, despite the unclear nature of property ownership, the existing complex and entrenched property rights nonetheless stymied bold and determined new plans for the city. Moudon (1986, p. XVIII) emphasized that one of the critical findings from her study of Alamo Square in San Francisco was the importance of the way that land was first subdivided. "The original gridiron which drew the line between public and private territories not only dominated patterns of change, but also remains as an indelible footprint of city form." In fact, Moudon (1986, p. 134) contends: "the single most powerful determinant of urban architecture is the ownership structure of the land."

Figure 1: Evident property ownership post-Katrina

Five years after the destructive fury of hurricane Katrina, areas of New Orleans, such as the Lower Ninth Ward, remain decimated and barren in places; yet the otherwise hidden power of plot lines, street rights-of-way, and infrastructure are still obvious. Figure 1 shows a clear spatial demarcation of property lines made manifest by the mere maintenance of vegetation and fragments of built infrastructure such as sidewalks and utility lines. Breunlin and Regis (2006, p. 745) note that since Katrina, many residents have used the power of property ownership to contest forced displacement. Raynard Casimier Sr., a New Orleans pastor and property owner, is quoted in the local paper as saying, "Somebody wants our dirt. Disaster is big money. I want to see my people come back for their dirt" (Breunlin & Regis, 2006, p. 745). The ownership of land has at times formed the legal basis for citizenship rights, and still serves to anchor a cultural citizenship in the U.S. Breunlin and Regis also note that U.S. citizens are incensed by state use of eminent domain where it infringes on the rights of property owners. Although we shall further investigate the contributions to structural inertia by sense of place and social infrastructure in section 2.4, there is clearly a broad range of inertial factors involved with property ownership and other equally strong associations with the land. In fact, proprietary rights are assumed without hesitation even in situations where legal property ownership is uncertain, and a specific social or ethnic group inhabits a local community playground or other territory (Fried, 2000, p.193). Indeed, many societies maintain a strong identity between place and people. "This social image is the primeval core of territorial identity…a latent assumption that people belong to the land" (p.194).

Even prior to the legitimization of individual property ownership, the Laws of the Indies proposed a design scheme for New Orleans and other planned North American cities. Original city plans have created powerful inertial forces in the development of those cities. Anderson (1993, p.110) describes a founding plan as: "a system of artifacts that provides conditions of support and constraint over time." In the case of Savannah, Georgia, Anderson contends that the original 1733 Oglethorpe plan for the city has successfully constrained large-scale development over time due to its unusually limited block size. Anderson adds that this condition of diminutive city blocks has also influenced other inertial factors in the morphogenesis of Savannah, including: "a continuously built street edge, which in turn, provides the opportunity for an active exchange between public and private space."

Stahura (1979, pp. 938-940) succinctly describes another political/legal process that increases the structural inertia of established suburbs. He notes that existing and well-established neighborhoods "play an active role in selecting in-migrants with socioeconomic characteristics consistent with those of the resident population. Control over the zoning laws is probably the most efficacious—new housing is typically required to closely resemble existing housing." Moudon (1986, p. XiX) also indicates that although zoning is often cited as the culprit in the separation of land uses in North American cities, "the phenomena actually has roots in the latter part of the nineteenth century, and perhaps earlier, when entire neighborhoods sought to redistrict land uses via covenants." Certainly Houston is a prime example of alternate forces of inertia at work, since it has no zoning code. Part of the reason that Houston resembles most other large North American cities is that developers employ widespread private covenants and deed restrictions, which serve a comparable role as zoning (Coy, 2007). Stahura also points out that even the vigorously enforced maintenance in well-established suburban neighborhoods can be part of the informal and formal inertial processes aimed at reproducing the status quo in both physical form and perceived image (Stahura, 1979, p. 938; Moudon, 1986, p. 141).

2.2. PHYSICAL: INFRASTRUCTURE AND THE BUILT ENVIRONMENT

In many ways, the forces of structural inertia correlated with the built environment are the most visible and comprehensible. Scheer and Ferdelman (2001, p. 25) argue that "early streets and subdivisions form a kind of destiny of a place—they limit the extent to which normal social and economic changes can really affect a place." In Arnis Siksna's (1997, p. 29) study of the effects of block size and shape on the morphology of cities, he demonstrated that certain sizes and dimensions of the most basic element of urban form—the city block—were better suited to the stability and persistence of urban form. In examining the effect of block sizes in twelve different cities in the U.S. and Australia, Siksna determined that where initial block sizes were small or medium, the street and block patterns remained intact over time––they were relatively inert. Portland, Savannah, and Seattle, with relatively small blocks, were found to have undergone few changes and were the most stable type of division—particularly small square blocks. In the cities with larger block sizes, such as Adelaide, the author found that the street and block patterns had been considerably modified. The study suggested that large blocks were more easily reconfigured by the insertion of new streets, alleys, and arcades. Further, the researcher contended that smaller blocks were more persistent than larger blocks "because they produce a finer-mesh circulation and finer-grained block and urban fabrics" (Siksna, 1997, pp. 22-25; Scheer & Ferdelman, 2001, p. 15). Smaller blocks also allowed greater numbers of intersections with more directional choice promoting easier circulation. The case could be made that smaller block patterns with finer mesh circulation exhibit more stability over time, and therefore manifest more structural inertia than larger blocks. Anne Moudon's seminal work on the Alamo Square neighborhood of San Francisco (1986, p. Xviii) presents a number of clues to the structural inertia of built form at several different scales at different points in time. At the scale of the urban block, Moudon notes that the permanence of the gridiron division of streets and blocks in the early residential sections of San Francisco is one of the most apparent features of the neighborhood: "surviving essentially intact throughout the development of the city" (Moudon, 1986, p. 134).

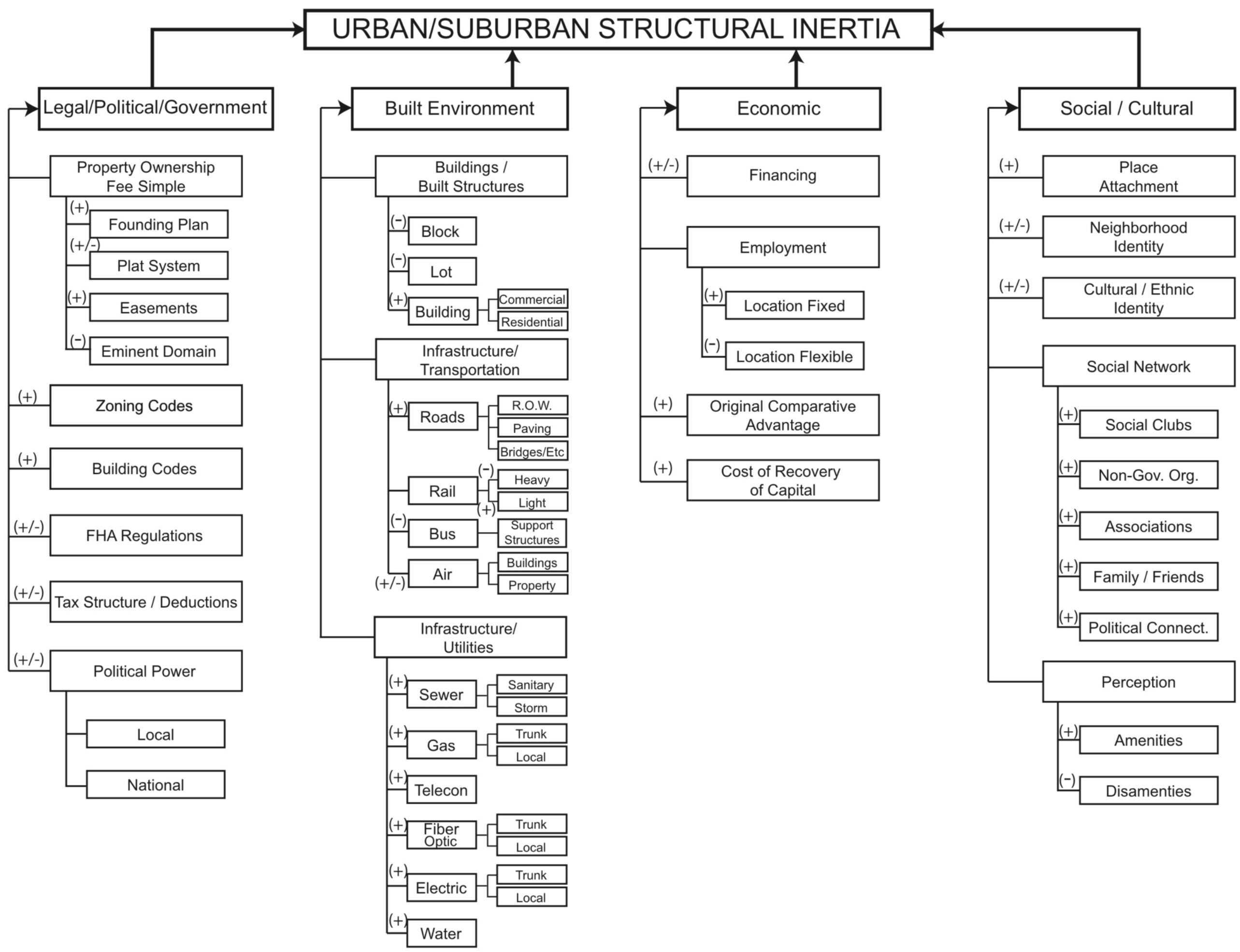

Figure 2: Diagram of Factors Affecting Structural Inertia

Within the scale of the block, Moudon (p. 134) observed that small lots as territories of ownership affect building form and change, and are significant mechanisms regulating urban form. The subdivisions of lots is "another structural element that has proved hard to remove:" again suggesting a high level of structural inertia in both small blocks and small lots within the block. In Siksna's (1997, p. 30; Moudon, 1986) study, he finds agreement with Moudon's findings: that "small lots produce more predictable building forms and fine-grain block fabrics." Both studies also agreed that inserting alleys and subdividing block interiors more easily, and more commonly, modified large deep blocks. Additional inertial force mechanisms highlighted by the Alamo Square study included; small lot size affecting the footprint of the buildings and their position relative to the street, and the fact that the original houses were built and sold in small parcels so that the next generation of houses had to be "consistent with the original increment of space" (Moudon, 1986, p. 141). The study also indicated that lot size affects the rebuilding—and thus rate of change—within the urban fabric. More time, difficulty, and costs are involved in assembling smaller lots for larger or different land uses. "As a result, the smaller the typical lot in any given area, the greater the difficulty of changing the environment." In other words: as lots decline in size, structural inertia increases, ceteris paribus.

In a study of the morphogenesis of a first-ring residential neighborhood in Cincinnati, Scheer and Ferdelman (2001, p. 20) identified four important factors that they found to correlate with the survival of historic buildings in the neighborhood: (1) street width and continuity; (2) lot configuration within the block; (3) building size; and (4) land use. They also found that several or all of these factors could be interrelated in their effect on city morphology. The widest streets appeared to be the ideal location for larger commercial and industrial buildings, and were more vulnerable to obsolescence, disuse, abandonment, and finally destruction. In the case of the largest through-streets in the neighborhood, 90 per cent of the original 1891 buildings had been destroyed by 1991. The largest through street, Central Parkway, provides an interesting interaction of inertial forces (Scheer & Ferdelman, 2001, p. 20). The right-of-way for the parkway was originally a canal, and the central focus for employment in the area. As the waterway fell into disuse because of the advent of the railroad, the indelible right-of-way of the canal provided a much-needed corridor for through traffic, when filled-in and paved-over. The width and size of the resulting connector boulevard then shaped the land use and building sizes along its length. As the proximity to transportation for commerce increased the value of the lots and blocks along the boulevard, more valuable land uses requiring larger-sized lots such as; multi-story commercial buildings, warehouses, breweries, and factories were developed. In a common inner-city pattern, white-collar residents then fled the changing land use to the new suburbs. As technological and economic advances made the factories, warehouses, and breweries eventually obsolete, many were abandoned and demolished. The narrower and discontinuous North-South streets in Scheer and Ferdelman's study did not go through a similar cycle of obsolescence and demolition. Buildings on these streets were five times more likely to survive (p. 23). Of the buildings in the study area, the most likely to change—demonstrating the least structural inertia—were the very smallest buildings at less than 700 S.F., and the second most likely to change were the larger buildings. Standard single or double row houses with commercial use on the first floor were the most structurally inert. Scheer and Ferdelman (2001, p. 25) note that the larger nonresidential buildings were less flexible than the standard row house, and were more expensive to renovate: for this reason, they were more susceptible to the forces of change, and many did not survive.

In a discussion of the how the original comparative advantage of urban areas continue to shape cities, Song (2009) has noted the tendency of the petrochemical industry in Houston to continue to persist in its current spatial pattern partially as a response to the extreme value of its associated infrastructure. Certainly, pipelines, seaports, railroads, and highways have demonstrated structural inertia in the case of Houston's petrochemical infrastructure to resist migration or spatial change. The interaction of structural inertia in various infrastructure subsystems is also significant. Herman and Ausubel (1988, p. 9) note that coal-use, railroads, and the telegraph all grew simultaneously: as did highways, autos, telephones, and the use of petroleum. The authors also note that there is a complex and variable mix of competition and dependency between infrastructure systems—in fact, transportation and communication systems may even advance and decline in tandem. It is important to remember as we proceed, that the structural inertia of road and utility rights-of-way also affect the persistence of the utilities and technology using these same corridors. Melosi (2000, p.425) proffers the idea that this dependence on permanent paths or routes has constrained the choices of current infrastructure designers. Current engineers and planners must maintain or expand systems that were designed generations in the past for different circumstances, "or face extraordinary costs." Policy decisions on spending for new infrastructure are also influenced by the location and pattern of existing infrastructure. There is a significant push to repair and widen highways rather than build anew—partially because of cost implications—but also because the developed spatial patterns reinforce the existing structure. Melosi (2000, p.425) also notes that sometimes "systems were designed to be permanent, to resist change, in order to justify their worth to the contemporary community:" perhaps indicating that even the perception of efficiently spent public funds may increase structural inertia.

Discussing the longevity of urban infrastructure in the U.S., Maryland and Weinberg (1988; Herman &

Ausubel, 1988, p.19) note that a surprising number of systems last longer than expected, or designed for. Certainly this is true of dams, power plants, and bridges. The authors also note the permanence of rights-of-way and the essentially eternal nature of sites. "Even if roads and plants decay, their routes and the sites on which they are located appear to have immortality. It is easier to widen roads or add to sites than to obtain territory for new infrastructure. The man-made backbone of our society is probably well established and unlikely to change." Maryland and Weinberg (1988, p. 328) also clarify a difference in inertial forces between current technology and routes or sites. Obsolescence of technology or design may not arrive in the inability of the transmission line or bridge to perform its designed function anymore, but in the changing requirements of the city. For example, even if a bridge was designed for permanence in structure and maintainability, it may prove inadequate if the changing morphology of the city makes the bridge a bottleneck to growing traffic (p. 329).

2.3. ECONOMIC

In a study undertaken to derive a model of the evolution or persistence of "status" in 714 North American suburbs, Stahura (1979, p.938) noted that among the factors that accounted for the inertia of suburbs was: "the fact that housing is a durable commodity initially designed for occupancy by a particular income group with certain family size characteristics." He also indicated that changes to housing typologies are expensive and occur only if other non-resident groups have high demand, or if there is a considerable drop in the demand from the existing neighborhood residents. Stahura added that this mismatch condition has occurred in the core of older central cities where first-ring middle-class neighborhoods found themselves in the path of rapidly expanding populations of inner city or blue-collar residents with very different housing needs, such as: larger families, single or transient residents, and required proximity to public transportation. At the same time that the central city was expanding, the original white-collar residents of the neighborhoods were turning their attention to outer suburbs or peri-urban areas where transportation changes and government-backed financial arrangements made these new areas more attractive (Stahura, 1979, pp. 938-939). In discussing the inertia of housing patterns in decaying cities such as Detroit or Cleveland, the economist Edward Glaeser (Glaeser & Gyourko, 2005; Glaeser, & Shapiro, 2003) noted that although the price of housing had fallen well below the replacement value of the physical structure, and jobs and social/cultural amenities had essentially vanished, people still lived in the houses. He surmised that the physical structure of the residents' homes retained a certain life-span value simply as infrastructure. Economic models of agglomeration provide an explanation of why people stay in cities after the loss of the original comparative advantage. Still, these models don't explain persistence of cities like Detroit and St. Louis that also have both low wages and high unemployment. Glaeser and Gyourko offer a more prosaic reason than agglomeration models: "these places have houses, and houses are very durable. When cities decline, housing prices fall and people continue to live in the houses. To a first approximation, there is a one-to-one correspondence between the number of homes in a city and the number of people in that city. It takes decades, if not centuries, for the housing in cities to disappear, and while the houses remain, the cities remain, attracting residents with homes that cost a fraction of new construction costs" (Glaeser & Gyourko, 2005, p. 3).

Stahura's study (1979, p. 940) also indicated that employment specialization of a neighborhood was inversely related to population growth. The researcher concluded that as an area "becomes more specialized as an employment center and an inertia in land use emerges, the potential for population growth is diminished." Further, as more land was dedicated to employing activities for the job specialty, less land would be available for new housing developments. Both Sathura and earlier researchers in the late 1950s and 1960s found that the role a suburb played in the metropolitan division of labor at the time it was developed determined, to a large extent, the characteristics of the initial population. Additionally, the persistence of a suburb's functional position assured that outward-migrating residents were replaced with inward-migrating residents of similar composition, and the formal characteristics of the neighborhood remained essentially the same (Stahura, 1979, pp. 946)—an example of reproducibility increasing inertia. The researchers also concluded that the suburban population composition, land use, and roles tended to persist once the neighborhood had attained a stable employment or residential character compared to the neighborhoods around it: that is to say, structural inertia increased with age.

2.4. Social/Cultural: The Inertia of the Real and Perceived Social Fabric

In the remarkably thorough and insightful book Root Shock, psychiatrist and researcher, Dr. Mindy Fullilove (2004), presented the results of her eight-year study of loss and grief in people displaced from their homes and neighborhoods by over twenty-four years of US Federal Urban Renewal. She described a moment of critical clarity in one of her many interviews of displacement survivors: "I realized the loss he was describing was, in a crucial way, the collective loss. It was the loss of a massive web of connections—a way of being—that had been destroyed by urban renewal; it was as if thousands of people, who seemed to be with me in sunlight, were at some deeper level of their being wandering lost in a dense fog, unable to find one another for the rest of their lives. It was a chorus of voices that rose in my head, with the cry, 'We have lost one another'" (Fullilove, 2004, p. 4). What Fullilove describes as a "massive web of connections," this "way of being," is a succinct introduction to the next category of inertial factors: the social and cultural fabric of society.

In a study of people displaced from the West End of Boston, Marc Fried (2000, p.194) argued that the people-place relationships he found were profound attachments people had developed to the communities that they lived in—communities where they shared familial, communal, and ethnic or cultural bonds with their neighbors. These were intimate links between people and places that "may extend beyond the home and the street into a wider area where a sense of belonging is established." Fried also notes that this attachment to place is often most profound when human relationships are encompassed in-group affiliations, and when identity is based on cultural, class, ethnic, or racial parameters (p. 195). This complex socio-cultural framework with the added distinction of class or ethnic overtones is fundamental to "welding an array of physical streets into a loose sense of community." When the West End residents in the neighborhood were displaced by urban renewal, Fried came to the startling realization that the grief and loss of a community—or even of a building that symbolized the neighborhood—could manifest grief and mourning similar to the death of an individual. From this and other studies of dislocation in the middle 1960s, the concept of spatial identity began to emerge (Fried, 2000, p.197; Proshansky, Fabian, & Kaminoff, 1983). Spatial identity designates the geographic or physical dimension within which "houses, streets, even whole communities can bound, intensify, and provide a spatial locus for identification and community attachment linked to social group identity" (Fried, 2000, p.197). Fried postulated (2000; Fullilove, 1996, p. 1520) that: "We might say that a sense of spatial identity is fundamental to human functioning. It is based on spatial memory, spatial imagery, the spatial framework of current activity, and the implicit special components of ideals and aspirations." At the extreme end of place-attachment, the bonds can even become dysfunctional, when the desire to cleave to the fragments of a home, which has been physically or socio-culturally destroyed—even against all possibility of living there again. Resistance to change in a place that is so extreme that it has become indelibly attached to the psyche is certainly a force of structural inertia.

3. The Model: A Conceptual Framework of Structural Inertia

The diagram in Figure 2, Factors Affecting Structural Inertia, summarizes the inertial factors listed in Section 2, and their positive or inverse relationships to structural inertia. In Section 3.1, we investigate an organizational ecology model of structural inertia for relevant clues in developing a framework for inertia in urban morphogenesis. Combining our factor diagram and certain earlier precedents, Section 3.2 then presents a model diagram and matrix that integrate pertinent characteristics into a hypothesized mechanism of structural inertia—including suggested moderating variables of age, size, and homogeneity; and citations of relevant sources. Finally, section 4.0, suggests a methodology for operationalizing our model of urban structural inertia for use in the study of urban persistence and resilience.

3.1. Precedents for a Model of Structural Inertia

In the early 1980s, Michael Hannan and John Freeman (1984) introduced the notion of structural inertia to the field of organizational ecology to help explain the forces of change and persistence in the dynamics of large corporations. Hannan and Freeman argued that all biotic evolutionary theories assumed that the creation of new strategies and structures in the animal world are random with

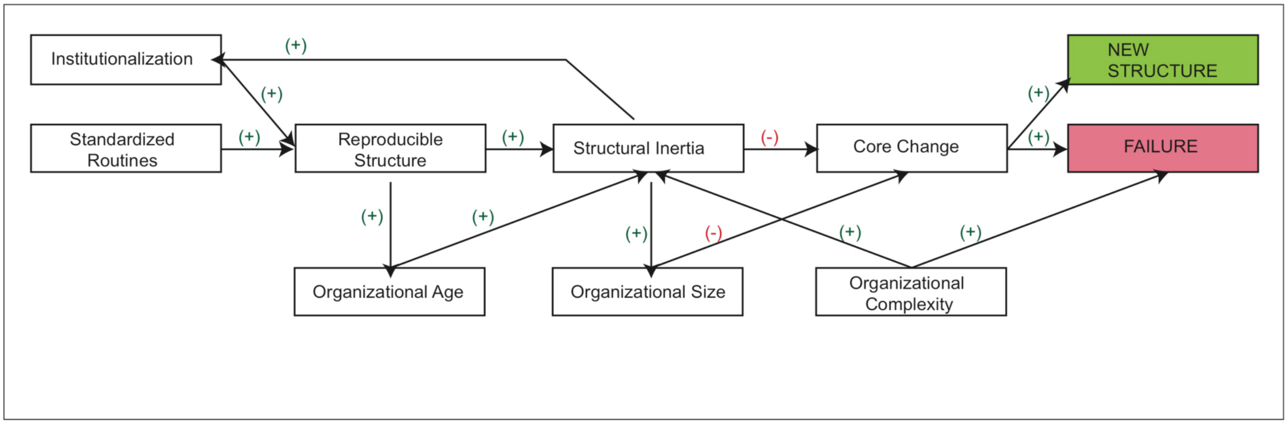

Figure 3: An Organizational Ecology Model of Structural Inertia Source: (Hannan & Freeman, 1984; Kelly & Amburgey, 1991)

respect to adaptive value: "Innovations are not produced because they are useful; they are just produced. If an innovation turns out to enhance life chances, it will be retained and spread through the population with high probability; in this sense, evolution is blind" (Hannan & Freeman, 1984, p. 150). It was their basic contention that the key to understanding organizational evolution was not to look at the adaptability of individual corporations, but instead to look at the population level of organizations. They sought to explain most of the observed changes in organizational features, not as planned or unplanned adaptations to existing organizations, but as selection and replacement at the population level (p. 150). They then surmised that selection in populations of organizations favors corporate forms with high reliability of performance and high levels of accountability. Further, that reliability and accountability require that organizational structures be highly reproducible: In other words, organizations are selected at the population level based on their ability to maintain the same image, product, service, use of input materials, performance, and so forth, both over time and across the entire structure of the corporation. In order to achieve a high level of reproducibility, organizations maintain singularly standardized routines and constant processes of institutionalization. The critical realization of Hannan and Freeman was that the much-valued goal of reproducibility is a double-edged sword. "The other edge of the sword is structural inertia. The very factors that make a system reproducible make it resistant to change" (Hannan & Freeman, 1984, p. 154). Just as with urban neighborhoods, Hannan and Freeman realized that inertial pressures on existing organizations are high, but that structural inertia is a consequence of a selection process rather than a chosen and desirable precondition for selection. The authors also proposed that inertial forces vary with the age, size, and complexity of an organization.

Hannan and Freeman also argued that the relationships between the factors of structural inertia could not be considered statically. In the development of our model, it is assumed a priori that urban processes should be considered dynamically. To claim that urban morphology is subject to strong inertial forces is not the same as claiming that urban fabric does not change. Rather, it means that urban neighborhoods respond relatively slowly to the occurrence of threats and opportunities in the environment. Therefore structural inertia must be defined in both relative and dynamic terms (Hannan & Freeman, 1984, p. 151). It is also helpful to remember James Vance's (1990, p.6) observation that the study of urban processes poses "a real problem: how can a continuous force be captured for observation and analysis? We may start with rather scant, or gross, phenomena, leading to a statement of basic process relationships, and hope as more information is made available to refine that statement."

3.2. Structural Inertia in an Urban Setting

From the Hannan & Freeman organizational ecology model of structural inertia, and the inertial forces discussed in Section 2, we then began to frame an inertial model of urban persistence. The first question we considered was: What is the nature of evolutionary change in an urban/suburban neighborhood? One point of view is what might be called a theory of random transformation (Hannan & Freeman, 1984): that neighborhoods change mainly in response to endogenous processes that are only loosely coupled with the desires of community residents, businesses, leaders, and environmental pressures for change. A second point of view might be called a theory of rational adaptation, which proposes that changes in neighborhoods reflect purposeful and rational responses to environmental pressures, threats, and opportunities—a Lamarckian proposition. A third perspective might be termed selection and replacement: suggesting that most of the variability in the morphology of suburban or urban communities comes about through the development of new neighborhoods and the replacement of old ones—a Darwinian notion. Even when actors strive to cope with their environments, "action may be random with respect to adaptations as long as environments are highly uncertain or the connections between means and ends are not well understood. It is the match between action and environmental outcomes that must be random on the average for selection models to apply" (Hannan & Freeman, 1984, p. 151). The use of selection and replacement mechanisms also hinges on the degree to which a neighborhood is under the guidance or control of rational and informed actors. Finally, even if rational and informed actors are ostensibly in control of the pattern of development of a community, and the structure of the neighborhood is responsive to the planned changes: the speed of the changes must be commensurate with the temporal patterns of the threats or opportunities. For example, if the leaders of a neighborhood realize that certain land use changes must be made in order for the community to deal with increased pressures from developers, and the leaders are able to make functional and rational decisions to accommodate or resist changes: the speed of enacting the alterations must still equal the speed of the threat, or the change may make the threat worse. "Therefore, structural inertia must be defined in relative and dynamic terms" (Hannan & Freeman, 1984, p. 151). If urban or suburban morphological change is not rational, under control, and timely: and the pressures for change are both endogenous and exogenous; then the most likely nature of urban evolutionary change is selection and replacement.

Figure 4 diagrams our tentative model of the structural inertia mechanism. Beginning with four inertial factor categories (see Figure 3 and Appendix A for additional explanation), we have indicated that increased levels of the factors occurring in each category may correlate with increased levels of inertia: indicated by the (+) symbol. Also deriving from the search of relevant literature, we contend that three characteristics of urban or suburban neighborhoods act as moderating variables in the generation of structural inertia: (1) neighborhood age, (2) neighborhood size, and (3) neighborhood homogeneity. If we hypothesize that the evolutionary process of urban morphology is selection and replacement, then the following statements may be asserted:

- Selection at the population level of urban areas favors neighborhoods with high reproducibility

- High levels of reproducibility of structure generate strong inertial pressure

- The process of selection and replacement favors neighborhoods that are difficult to change

- Structural inertia is moderated by the neighborhood variables of age, size, and homogeneity

Referring again to Figure 4, as factors increase in each of the four categories, and they are modified by the variables of age, size, and homogeneity, the reproducible nature of the neighborhood is increased or decreased. Increasing reproducibility correlates with increases in structural inertia. Depending on the ability of structural inertia in the neighborhood to resist endogenous and exogenous pressures for transformation, a core change in the character of the neighborhood may occur. If a core change occurs, the neighborhood may successfully transform and reset the clock on inertial factors. If the neighborhood does not successfully transform, the neighborhood may either begin a process of decline, or be bypassed or leapfrogged in favor of newer neighborhoods.

- All other things being equal, the faster the speed with which new neighborhoods can be built, the greater is the relative inertia of existing communities

- When the costs for building new neighborhoods are low, and the period from design to construction is short, the threat is intense to extant neighborhoods—unless there are legal barriers such as zoning, to new competing neighborhood developments

- As an urban neighborhood ages, more intensely utilized land precludes expansive new housing or employment development. Thus older suburbs have less potential for population growth reflected with the lessening availability of land for housing development (Stahura, 1979, p. 940)

If a core change does not occur, levels of inertia will continue to increase as they feed back through the original factor categories. As increasing levels of inertia make the neighborhood more rigid and inflexible, even the minor levels of change required day-to-day can eventually lead to either decline, or bypass to new, less costly, alternative neighborhoods.

4. CONCLUSION

The purpose of this essay was to present our ongoing research regarding a new notion for understanding urban morphogenesis, which we have termed structural inertia—the tendency of an urban area to resist change due to its existing physical, economic, social, and cultural fabric. Through a review of recent literature, we have identified and cited four categories (Figure 2 and Appendix A) of factors that appeared to correlate with the forces of structural inertia. We then examined a similar model of inertia from the field of organizational ecology (Figure 3) and developed a diagram hypothesizing the mechanism of structural inertia in an urban setting (see Section 3.2 and Figure 4).

The next step in our research will be the process of operationalizing our model in order to empirically assess the relative levels of structural inertia inherent in specific real-world urban or suburban environments. In order to accomplish this task, we have focused on the most immediately accessible and quantifiable factors that appear to correlate with higher levels of inertia. Within the built environment category of factors, we are developing a pilot study that looks at buildings, other built structures, lots, blocks, and infrastructure: particularly roadways. Early indications are that a combination of space syntax theory as a metric for infrastructure can be used in combination with a Conzenian morphological approach for the measure of inertial factors in built form. Concurrent with investigations into the efficacy of research methods, we are examining suburban locations for the deployment of the pilot study.

5. APPENDIX A

6. REFERENCES

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Appendix A: Matrix of factors correlated with structural inertia, moderating variables, and their hypothesized relationship

Categories of Urban *Structural Inertia* Factors			Moderating Neighborhood Variables			Source References
Primary	**Secondary**	**Tertiary**	**Age**	**Size**	**Homogeneity**	
Legal/ Political/ Government	Fee Simple Property Ownership	Founding Plan				(Anderson, 1993), (Lynch, 1972),
		Plat System				(Breunlin, & Regis, 2006), (Campanella, & Vale, 2005), (Fried, 2000), (Moudon, 1986), (Sheer & Ferdelman, 2001)
		Easements				
		Eminent Domain				
	Zoning Codes / Building Code					(Hayden, 2003, p. 233), (Moudon, 1986), (Stahura, 1979),
	Covenants / Deed Restrictions					
	FHA Regulation					
	Tax Structure					
	Political Power	Local				(Schwirian, 1983)
		National				
Built Environment	Buildings/ Built Structures	Block				(Anderson, 1993), (Moudon, 1986), (Sheer and Ferdelman, 2001), (Siksna, 1997),
		Lot: Size / Shape				
		Building				
	Land Use	Commercial				(Sheer & Ferdelman, 2001), (Siksna, 1997),
		Residential				
		Public/ Institution				
	Infrastructure/ Transportation	Roads				(Sheer & Ferdelman, 2001), (Siksna, 1997),
		Rail				(Warner, 1962)
		Bus				
		Air				
	Infrastructure/ Utilities	Sewer				(Herman, & Ausubel, 1988), (Maryland, & Weinberg, 1988), (Melosi, 2000),
		Gas				
		Telecom				
		Fiber Optic				
		Electric				
		Water				
Economic	Financing					
	Employment	Location Fixed				(Stahura, 1979),
		Location Flexible				
		Specialization				
	Original Comparative Advantage					(Glaeser & Gyourko, 2005), (Glaeser & Shapiro, 2003), (Stahura, 1979), (Song, 2009)
	Cost of Recovery of Capital					
Social/ Cultural	Place Attachment					(Fullilove, 1996), (Fullilove, 2004), (Fried, 1963), (Fried, 2000), (Proshansky, Fabian, & Kaminoff, 1983),
	Neighborhood Identity					
	Cultural / Ethnic Identity					(Breunlin, & Regis, 2006), (Fullilove, 2004), (Hunter, 1971). (Simone, 2004), (Stahura, 1979),
	Social Networks	Social Clubs				
		Non-Gov. Org.				
		Associations				
		Family Friends				
		Political/Social				
	Perception	Amenities				
		Disamenities				

Hypothesized relationship of moderating variables to inertial factors

Represents a positive relationship to inertial factors

Represents an inverse relationship to inertial factors

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