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# Organization by form: Applying systems theory to urbanization

Michael Patrick Howe
*University of Nevada, Las Vegas*

# ORGANIZATION BY FORM: APPLYING SYSTEMS THEORY TO URBANIZATION

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Michael Patrick Howe

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[redacted]
*Examination Committee Chair*

*Dean of the Graduate College*

[redacted]
*Examination Committee Member*

[redacted]
*Examination Committee Member*

[redacted]
*Graduate College Faculty Representative*

ABSTRACT

**Organization by Form: Applying Systems Theory to Urbanization**

By

Michael Howe

Prof. Robert Dorgan, Examination Committee Chair
Associate Professor of Architecture
University of Nevada, Las Vegas

I have come to believe that the core of our declining physical, mental and community health dwells in the current practice of land use based development. Although today's land use codes began as a legitimate response to protect people's health and welfare it has since devolved into an unsustainable process. The failure of land-use zoning is rooted in an informational disconnect created by the segregation of land into distinct uses while offering generic design standards. Whereas the current mode of land use-based zoning results in an unpredictable physical form, Form-Based Codes foster a connection between the individual to the available networks of public space and circulation in a language that is commonly understood. The urban process has gone from prescriptive traditional responses to proscriptive regulations.

The solution may well in an evolving development process exemplified by the recent discoveries made in self-organizing systems and emergent networks. I propose that we

pick up the discussion where Jane Jacobs's left off more than forty years ago in the final chapter her book, *The Death and Life of Great American Cities*, and look at the type of problem that urban development poses. It is my belief that there is a regulatory process available that can exceed the expectations of a sustainable urban environment. The core of this thesis is to explain how the Form-Based Code process is founded upon a self-organizing cycle of self-educating individuals who make positive contributions to urban development.

My chosen methodology begins with a general explanation of the typical Form-Based Code and the ways in which this regulatory process is adopted. This is followed by a brief examination of what constitutes a complex system and the common techniques of analyzing how it works. The tools for complex systems analyses are then applied the Form-Based Code process to illustrate its inherent self-organizing strength.

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I would also like to thank the City of Las Vegas, which has been a patient and gracious employer, and the Department of Planning and Development, who has provided plenty of experience to witness urban development in action.

Finally, I would like to thank the important thing in my life, my family. Without my wife's unending love and my two sons' enthusiasm my constant pursuit for a better city would only be half-hearted.

# CHAPTER 1

## INTRODUCTION

### Statement of the Problem

What is the problem with our contemporary building culture? There has been a measurable decline[1] in our social, mental, and physical health that is linked to the current suburban development pattern. Although this thesis is based upon this premise, I would offer that the overall decline in our societal health is the symptom of a larger problem. For the past eight decades there has been a steady transformation in the development culture from a prescriptive self-regulating process built on tradition to proscriptive protocols of institutionalized knowledge guarded by specialists. It has been this transformation of delivering hyper-accountability within given thresholds that has distracted the attention of delivering buildings with longstanding public benefit, or what I would call the decline in civitas –our ability to collectively create a livable environment that outlives each generation.

There is a paradox when you consider that some of the oldest buildings still used today –think of any cathedral older than a 100-years- would not be authorized by today's development standards. But these churches will likely outlive their newer counterparts. It has become common practice to witness a mortgage outlive the building it is financing.

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[1] *Understanding the Relationship Between Public Health and the Built Environment*, completed in 2006 by Dr. Reid Ewing and Dr. Richard Kruetzer.

The end product is the decline of individuals who trust in the future of their own habitat. The focus of this research looks at the regulatory structure of the Form-Based Code process by analyzing it as a complex process.

Land Use Zoning, hereafter referred to as Euclidean Zoning from its seminal Supreme Court ruling[2], has been categorizing the building blocks of a functional city – residences, shops and offices, schools and parks – into their own distinct geographic areas. Euclidean Zoning seeks to control the detrimental effects that made the industrial cities of the late 19th and early 20th century that were notoriously inhospitable. This is accomplished by requiring an increase of light and air, restricting uses and controlling building boundaries. Manufacturing is placed away from commerce, which is then placed away from schools and homes. The hierarchy of use places the single-family home at the top of a pyramid resulting in a net reduction of overall urban density. A side effect of restricting density is that the required connections to all of these separate zones rely on a transportation system that emphasizes private auto ownership and wide freeways as a compromise to keep the time required to transverse these segregated areas within a manageable timeframe.

Euclidean Zoning seeks to protect the financial investment of personal property by allowing for relative development predictability. Current use-based zoning regulations deliver public accountability through a process of administrative objectivity that describes the parameters for land development and requesting that future projects conform to these parameters. The process appears democratic and objective as the planner is provided little discretion in determining if a building is in compliance with the

[2] *The City of Euclid vs Ambler Realty Company 1926.*

zoning code; this decision for entitlement is typically held at the jurisdictional level of a planning commission or board.

## Significance

There are design standards within Euclidean Zoning, but they are too general to meet the fundamental purpose of design, which is to create a livable environment of measurable quality through site-specific solutions. In Euclidean Zoning, heights are listed as maximums, setbacks as minimums, and floor-area-ratios (FARs) attempt to control massing.

The first rule of a regulatory policy is to maintain the enforceability of its rules; if that becomes problematic then it has the ability to make the necessary adjustments through deviations –rather than policy adjustments. Because Euclidean Zoning design standards operate within a limited design vocabulary, builders often request to deviate from rules that do not adequately address a physical issue from the unique nature of a specific site. A policy inundated with requests for exemptions becomes burdened to justify its own existence. If the foundation of a process of development regulation is based primarily upon the intangibles of land use, it will drown under a constantly growing number of deviations and exemptions. The first obstacle required of all urban development regulation is that it must be calibrated to an anticipated physical outcome.

## Research Methodology

The conventional suburban development model used under Euclidean zoning is based on statistical quantities that do not describe or foster quality spatial design. By describing

urban morphology in terms of fractals and grid-connected network identifiers we create a set of rules that are aligned to these algorithmic processes. These rules trump all other issues such as style, density and use intensity, focusing on the levels of urban intensity. As in Leon Krier's drawing below from *Architecture: Choice or Fate* (1998), successful urbanism demonstrates a mixture of complementary uses that make for an enjoyable experience. As the drawing illustrates, it makes more sense to eat a pizza rather than a pile of pizza ingredients.

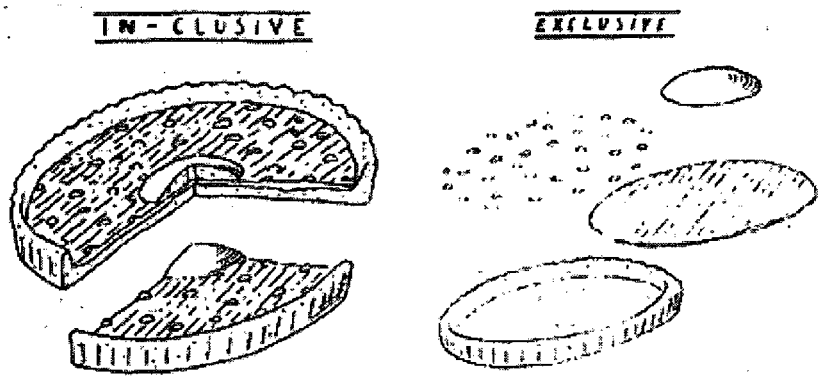


Figure 1. L. Krier's diagram demonstrating the appeal of mixed-uses

For this thesis I have chosen to look at the gains made in network sciences rather than the trends commonly discussed in urban sustainability. Sustainability is typically defined as the ability to meet one's needs today without compromising the needs of future generations. However, because of its relative vagueness, it provides little use for a establishing the quality of a given system's health. My fundamental reason for avoiding

the common definition of sustainability as a benchmark for system survivability in regards to this thesis is because according to the Second Law of Thermodynamics, 100% sustainability is not achievable. The sustainability of a given environment is a noble goal, much like the perpetual motion machine and the free-energy generator. If we are to make an argument for using the discoveries of complexity and emergence taken from the physical sciences, it is appropriate to demonstrate the limitations of sustainability within those same limitations.

The Second Law of Thermodynamics states that heat flows spontaneously from hot to cold and does not flow in the opposite direction (Cutnell and Johnson, 1998) illustrates that sustainability is ultimately impossible. To add to this, all spontaneous processes are irreversible, meaning that you can use available energy but you cannot create new energy. The universe is continuously expanding and our physical world is constantly working towards a state of entropy, or working towards a state of equilibrium (Cutnell and Johnson 1998).

In order to provide clarity to how sustainability is addresses by this thesis, I propose that we look at the sustainability of communication or how information is transmitted, rather than trying to focus our efforts on the ever-changing status of a given environment. At the root of organizational sciences and systems theory is the transference of information within a given space and time. This information is the coding of instruction that, in the scope of this thesis, results in the production of an urban environment.

## Thesis Focus

As a focal point of this thesis, I have chosen to continue where Jane Jacobs left off in the final chapter of her book, *The Death and Life of Great American Cities* (1992). In describing the type of problem a city is, Jacob's makes a recommendation that we should look at our present concerns of urban growth as a system of organized complexity. The most appropriate and capable mechanism that can deliver what is expected from sustainable growth today is the Form-Based Code, as it regulates the physical aspects that have the most bearing on establishing a self-organizing system.

The purpose of this thesis is to shed light on a more effective manner of guiding development towards a robust urban environment –rather than one that is just sustainable- and to present the core principles that seek to maintain that environment. Ultimately, a self-organizing cycle of self-educating individuals begins to actively contribute in their future development. This is what I would consider to be an emergent urban environment, and the ultimate idealistic societal quality.

The following chapters examine the nature of identifying and categorizing the problems in regulating urban design. I begin with a brief historical overview of urban planning and how cities have gone from a process of prescriptive tradition to proscriptive regulation that has limited the effectiveness of design in addressing urban issues. Chapter Three gives an explanation of what constitutes a Form-Based Code process and the minimum requirements to regulate by form. Chapter Four provides brief description of complexity, self-organizing systems, and complexity and their common methods for assessment and analysis. This chapter ends with an explanation of the algorithmic process and adapting that to the work of James Carse regarding finite and infinite games (1986).

Chapter Five synthesizes chapters three and four, giving an analysis on the effectiveness of the Form-Based Code process by demonstrating its ability to comply with the rules of organizing systems. Chapter six is a summary of the opportunities and constraints found within current Form-Based Codes and provides suggestions to ensure a successful development code.

## Definitions of Common Terms

The following definitions of terms frequently used are provided to offer clarity in the discussion of this thesis. The first, "urban", is a term that shall mean "the process and/or completion of a physical development that is bound by any anticipated affects it may have on its adjacent neighbors". The term "urban" describes a qualitative condition of place and is also a directional process in that a new project will cede to the contextual nature of its surroundings. This is a broad term but is given to clarify a pre-condition to this thesis. "Urban" is not the opposite of "rural" but rather its refinement. There is no urban without its start from the rural condition. For example, a single tent in the woods can be a rural construction, but will become an urban condition when the occupant of the tent begins to make accommodations to other campers. These accommodations can be a how the tent is situated, where the cooking occurs, the creation of a latrine, or any other factor to be accounted for that may have an impact on existing or future neighbors. The reason that "urban" definition appears general and contains no reference to "city" is that it is a primary condition from which a hierarchy of human development is based. Urbanism is a measurable gradient that implies an increase of conditional requirements with the increase of the density and intensity of the built area.

The next commonly used term is "Euclidean Zoning". The term gets its name not from the Greek mathematician Euclid or geometry, but from a landmark U.S. Supreme Court ruling that gave local jurisdictions police powers to use planning regulation to protect the public health, safety, and welfare. This term is relatively interchangeable with land-use planning, and is synonymous with conventional suburban development, as they all operate from a hierarchical pyramid of protected uses with the single-family home having the most protection from other uses.

The term used in this thesis as the counterpoint to Euclidean Zoning is "Form-Based Code". This term represents a process that has other names such as "Context-Based Zoning", "Smartcode", or "Transect-Based Code". The key difference from Euclidean Zoning's regulation of the intensity of use is that a Form-Based Code operates from a gradient of urban intensity known as a "transect". Within a transect are levels of scale that establish the typologies of buildings, streets and streetscapes, and public spaces.

"Complexity", "Self-Organizing" and "Emergence" are the three terms that represent a collective term often referred to as the "New Sciences". The reason for the "New-ness" is that these three terms are utilized in the physical sciences and mathematical theory. For this paper simplified working definitions are given in consideration of the limited scope of this thesis. "Complexity" is the first stage of organizational thought and analysis that deals with identifiable problems of multiple variables within a defined parameter. With the addition of a time component to complex problems we now begin to deal with "self-organizing" systems. The reason time is used to distinguish complexity from self-organization is that self-organizing systems demonstrate synchronicity. The complex variables in a self-organizing system begin to synchronize, coalescing into a unit with

defined boundaries. At the point that the self-organizing system begins to regulate itself in response to its surroundings it begins to develop "emergent" qualities. Emergent systems are networks of self-organized, complex variables that act as a single unit with the ability to strive for self-preservation.

# CHAPTER 2

## FROM THE PRESCRIPTIVE TO THE PROSCRIPTIVE

According to the City of Las Vegas Title 19 Zoning Code, a single-family home situated on a one-acre lot could not build an accessory structure that exceeds the gross floor area of the primary residence by fifty-percent without seeking a variance to operate outside of the parameters of the code. Oddly enough, the property owner could build a structure that would fill the entire lot as long as it met the general setback standards. So in this instance, a property owner could build a two-story 60,000 square-foot house without any reviews but would have to obtain approval via discretionary review process for a simple shed that may be slightly bigger than half the size than the house. The code creates an absurd requirement that a barn must be fifty-percent smaller than the farmhouse but a farmhouse can practically cover the entire lot.

Proscriptive limitations for an accessory structure, when regulated as a use, do not provide the flexibility found in the prescriptive regulations provided by building typology (a component of Form-Based Codes). In the context of a semi-rural neighborhood it is not uncommon to see some type of large shed or accessory structure that is larger than the primary residence. There are numerous examples in various municipal codes of where proscriptive requirements hinder contextual development. When the sole nature of a proscriptive code is to prevent development from adversely affecting its neighbors, you fail to acknowledge any positive contributions that a proposal may add to the

neighborhood. In terms of urban analysis, you are always starting off on a weak point and continue to work your ways backwards.

The core of this chapter outlines how an implicit form-based prescriptive process of urban development has developed into an explicit use-based proscriptive process. By "proscriptive" I mean a restriction to only allow what is explicitly expressed in the code. Form-based Codes works proscriptively as the flexibility for design-based solutions are available and uses are much more diverse. A Form-Based Code can allow taller buildings of greater densities if the proposed design can demonstrate that it can operate within the context of the neighborhood it is placed in.

## Beginning with Buildings

The history of the urban environment has been predominately a history of urban form up until the last 83 years. As such, the issue now is that the past 8 decades of increasing regulation have made a substantial effort to trump the past 6,000 years of traditional city building. Historically, our urban environments evolved under a growing knowledge base founded upon a collection of adaptations to the physical environment and the provisions made for the social needs of the community. These adaptations and provisions are what developed into generalized knowledge that became traditions.

Carpenters, masons, stonebuilders, and others regulated the development of their crafts with guilds and unions. These building cultures were established to ensure a consistency in practice, a protection of their livelihood, and as a means of ensuring a living for future generations. Amongst these specialists were generalists who would be the equivalent of what we expect from today's architects. An excellent example of this is

the Renaissance genius Filippo Brunelleschi, who is known for the construction of the Santa Maria del Fiore. Brunelleschi acted as sculptor, structural engineer, mason, and architect of the Florentine Cathedral completed in 1436, which is still in use to this day (King, 2000).

Even in pre-building code times, a builder was obligated to deliver a safe structure. One of the first legal areas established in Hammurabi's Code of Laws were the rules for the builder. In early times the builder was ultimately responsible for the construction of the building and its performance. This meant that if a house collapsed and killed the occupants the builder's would lose his life (Ching 2003).

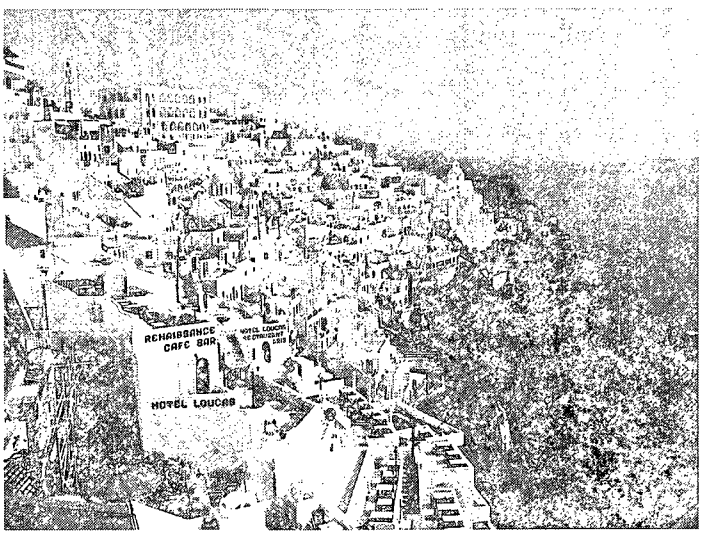


Figure 2. Photograph of the Santorini, Greece demonstrating fractal tectonics.

As this process continued, gradual developments in building technologies and infrastructure resulted in an increase of urban density. Then a transformation of

knowledge regarding public safety placed regulatory power into the hands of specialists in order to deliver greater assurances of safety to the individual and to protect those who could not grasp such detailed knowledge. Codification of safety and welfare began to replace the common sense of urban design traditions that transformed the requirements for life safety and sanitation into land use and density regulations. Although undoubtedly necessary, a casualty in this process was that problems that could be dealt with using practical methods for design deferred to more rigid procedural solutions. This is where further splintering of the development process occurs; building codes, zoning codes and subdivision laws (platting) that do not allow for adaptability in the way that a monoculture can produce greater yields, but of lesser quality and at risk of rapid downturns.

Like zoning ordinances, the basis for building codes emanated from historic fires beginning with Chicago in 1871. The first building codes began as a consolidated effort by private groups to address the conflicts encountered between various cities' codes. The National Board of Fire Underwriters had threatened not to insure any businesses until Chicago developed a building code in 1875 that dealt with fire hazards (Ching 2003). Despite common misconceptions, building codes are newer than many prevalent zoning codes.

The difference between the authority of building codes and zoning codes is that construction follows after entitlements have been granted. In some cases the mandatory fire setbacks stemming from building codes, based on the materials and type of occupancy are not in line with zoning setbacks. This often can be the cause of large delays in development in that the entitlement process is not closely linked to the

permitting process. Despite the multiple levels of specialized oversight, there is still little in the conventional suburban development process that prevents the individual from obtaining entitlements for a project that may not be in compliance with the adopted building codes.

Construction permits for buildings that cannot meet code are requested frequently enough that many jurisdictions adopt a clause that allows the local governing body to have the ultimate approval. While this can be argued as a means of providing flexibility, it also draws attention to the inconsistencies that surface when going from the use-based entitlement process to the construction-phase of the permitting process. This has become another opportunity for specialists that assure a proposal's fire safety, code-analysis, or even fire-sprinkler installation. The specialization of safety regulations cause further splintering in the development process; building codes, zoning codes and subdivision laws (platting) that do not allow for adaptability in the way that a monoculture can produce greater yields, but of lesser quality and at risk of rapid downturns.

## The Law of the Indies

The following events serve as snapshots of the emphasis of land use in regulating the functions of a city over urban design. I begin by investigating the early common urban patterns with a particular focus on events that lead to the regulation of urban development in the United States.

In 1573 the Law of the Indies had a great effect on the urban form of the "The New World". King Phillip's royal decree had an area of influence covering Latin America and many of the southern North American cities with its effects still visible today (Kostof,

1992). This is the first recognized lawful requirement that emphasized form and placement, thus creating the first known development regulation in North America[3]. The Law of the Indies regulated Spanish settlements that reached into what is now the United States and included detailed criteria regarding the design and location of a central plaza, the organization of civic buildings, the allowance for communal open space, and the separation of incompatible uses. There were even distinctions in the placement of the central plaza if the town was located on the coast (near the shore) or if it was located inland (centralized) (Duany, 2003). You can still see the mark of these plans on cities such as San Antonio, Texas and Saint Augustine, Florida to name a few cities in the U.S. Although there were some specific requirements in the Law of Indies, in general the rules provided could be best described as parametric, as it called out proportional requirements for the town size and shape, so as to allow for future growth that would continue from the initial settlement (Kostoff, 1993).

## The Jeffersonian Grid

The gridiron layout, the orthogonal pattern most people have come to familiarize an urban core, is originally credited to Hippodamus, the famous Greek town planner who brought straight and parallel streets to Piraeus around 450 BC (Jackson, 1985). Although it was an arguably effective pattern, it was basically shelved for 1500 hundred years, as the organic mediaeval plans developed around a royal piecemeal land distribution process. The early U.S grid plans showed up in cities such as Philadelphia, Savannah, and Washington D.C. whose radial plan is superimposed on a grid (Jackson, 1985).

[3] The Taos Pueblo, arguably predates the Law of the Indies, but continues to be inhabited sans any explicit regulation of form.

These cities were modeled after Sir Christopher Wren's success in London. Under Thomas Jefferson's direction, the U.S. was subdivided into one-mile squares, set within 36-square mile Townships, by the Continental Survey in 1803 (Duany, 2003). But it was not until the Homestead Act of 1862 that the nationwide grid was utilized in order to accommodate frontier expansion. As Kenneth Jackson states in *Crabgrass Frontier* the nationwide platting provided "at least the illusion of orderliness and prosperity that settlers associated with the big cities of the east" (1985).

The product of the Homestead Act was the creation of The Public Land Survey System, with its familiar Township Diagram. This diagram, still used today, contains 36 one-mile sections that are further dived into the quarter-sections (160-acres). From this act the Morrill Land Grant Act of 1862 followed, giving states sections 16 and 36 in each township for the support of common schools.

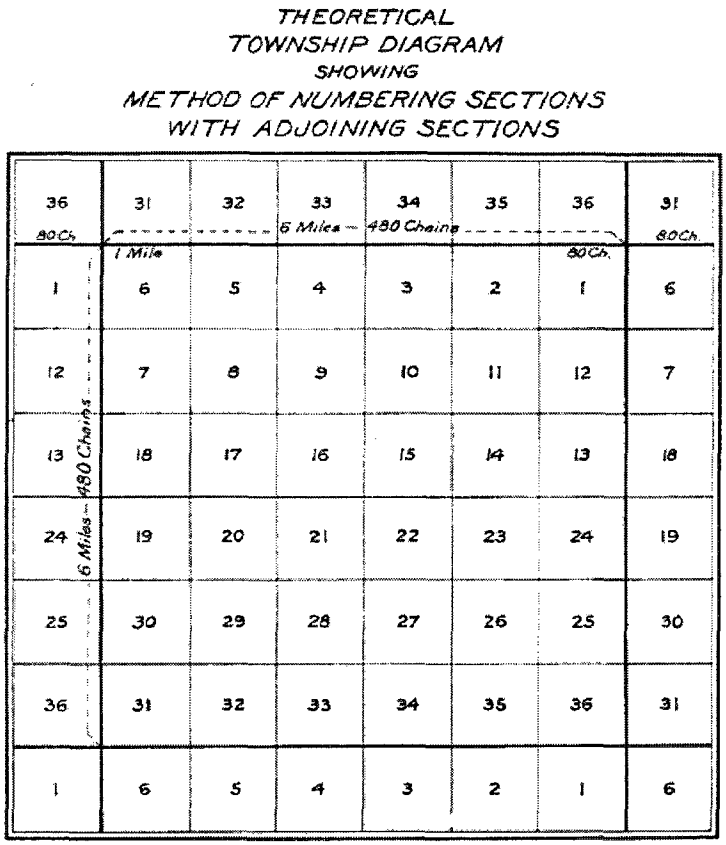


Figure 3. Township Diagram from the Public Land Survey System

The power behind the Homestead Act is that it establishes real property that has been recognized by the government. From real property you now have the first and foremost rule in development: you cannot receive entitlements nor build on other people's property without their explicit consent. Although it is possible to remap property into lots that may break from the section pattern, the resulting section grid has arguably had more influence on the resulting urban form by means of it affect on infrastructural requirements.

Public easements for future rights-of-way, known as township and section roads, are typically laid out along section boundaries. These roads are then spaced one mile apart so that growing urban areas start off with a primary street network of mile-long blocks. Over

time, and due to the distances covered, these roads have become the arterials or section line roads that today are primarily designed for auto-oriented transportation. In Euclidean Zoning, commercial development typically fronts along arterials and at intersections. The remainder of the square-mile section is then filled in with residential development, schools, churches, and parks. This regimented urban structure coincides with the similarly strict practice of Euclidean zoning, in which use of a property is dictated and regulated by zoning district, the boundaries of which often being derived from locations of arterials.

Congress granted land to the states for transportation systems and for public buildings. The largest grants went to railroads to encourage construction of the transcontinental lines. Between 1850 and 1871 when the railroad land grant policy ended, railroads received 175,350,000 acres from the public domain, although they later had to forfeit some 35 million acres for failure to meet construction agreements (Gates, 1968). The grid was the stepping point for land use to launch from.

### The 1901 Tenement House Act of New York State

The first land use regulations seen in the U.S were the early tenement laws created in response to the unhealthy living conditions of 19$^{th}$ century industrialized New York City. With the large immigrant population, not enough housing, and plentiful low-paying manufacturing jobs came overcrowded tenements under a constant risk of fire. In 1901 the Tenement House Act of New York State required that no tenements be built on less than 25-foot wide lots and required improved sewage conveyance and ventilation be installed (Jackson, 1985). Although there were requirements affecting a building's

general form, the act was largely unsuccessful in improving living conditions, hence the development of zoning laws in 1916 to control land use.

## The 1909 Plan of Chicago

One of the most notable products that came from the 1893 Columbian Exposition in Chicago, besides the City Beautiful movement, was the 1909 Plan of Chicago. The Chicago Plan was the first comprehensive plan for an American city created by Daniel Burnham and Edward Bennett with a broad scope that reached beyond the city limits and a thirty-year vision. A famous line attributed to Burnham was, "Make no little plans. They have no magic to stir men's blood..." This phrase is repeated to this day in many planning departments, whether in jest or seriousness. Today's version of the Chicago Plan still harks back to the call for planning action opening with, "This is no little plan. This is a plan for urban greatness" (Chicago Plan 2008).

One important component missing in the initial Chicago Plan was the restriction of plan amendments and lack of public participation during the creation of the plan. The Plan was presented and approved by the general public as a finished document. Another oversight in the original Chicago Plan was the lack of regulation over privately owned lands. At the time of the plan, municipal governments had little legal authority to control development on private property, as their right to use the police power was yet established. Constitutionally the state was the ruling authority in regulating the activity on private property in order to protect the public health, safety, and welfare.

## 1916 NYC Zoning Ordinance

Following the Chicago Plan of 1909 some states began legislating their own zoning enabling acts in order empower municipal governments. In 1916, under Attorney Edward M. Bassett, New York City adopted the first modern zoning ordinance in the United States based upon the state's right to police powers. Bassett sought to link each provision of the ordinance matter so that it fell within the scope of police powers, commonly phrased as "public health, safety, and welfare". This was done to frame the debate in determining a potential use as an entitlement endowed by the public rather than a prerogative of the landowner.

Unlike the visionary Plan of Chicago, the 1916 NYC Zoning Ordinance came in response to the pressures arising from a new concept: skyscrapers. The decreasing amount of land available for a rapidly industrializing city combined with a new subway system carrying thousands of workers pressured commercial construction to build vertically. Although the skyscraper was a natural response to the pressures of high density growth, some projects were reducing the amount of available sunlight and fresh air by taking up entire city blocks with building heights of up to fifty stories. Bassett's plan was to create an overlay district that regulated building height in proportion to street width as a remedy to reducing congestion while increasing available light and air. The entire city was divided into ten districts.

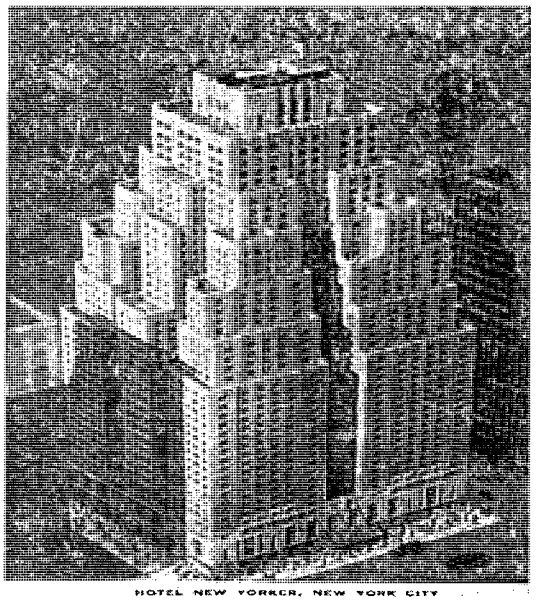


Figure 4. A postcard showing The Hotel New Yorker (NYC Library)

Nine of theses districts were given distinct uses: a residential district, four retail districts, two business districts, one manufacturing district, with the tenth district allowing for the mixture of uses. Five of these use districts were regulated by lot coverage and minimum lot sizes. This mandated increased setbacks for skyscrapers as the building height increased. This portion of the ordinance is responsible for the distinct Manhattan skyline of ziggurat-like skyscrapers (see figure 4). The New York zoning ordinance failed to regulate physical design beyond basic setbacks and density restrictions to permit light and air and to reduce congestion. The provisions also served to "prevent the intrusion of improper uses into homogenous areas" (Nolan, 2006). Almost immediately, communities across the country enacted similar regulations.

## The Standard Enabling Acts

Following the success in New York with the 1916 Zoning Act, the U.S. Department of Commerce published the Standard Zoning Enabling Act in 1922. This provided model legislation on which states could base their enabling legislation, essentially standardizing the practice of zoning in the country. The resulting Standard State Zoning Enabling Act (today referred to as the Standard Enabling Act) extended the authority given to the states by the Department of Commerce, under the direction of Secretary Herbert Hoover in 1924. Edward Bassett was brought in to write the Standard Enabling Act after the success of New York City's 1916 zoning ordinance. The New York City ordinance, which was developed in response to the problems of early 20th century industrialization, became the template for land use regulation across the United States (Nolon, 2006).

The Standard City Planning Enabling Act of 1928, a refinement of empowerment given to local jurisdictions and municipalities, followed the Standard Enabling Act of 1926 upon the ruling of the Supreme Court in 1926 (see below). The results of the Standard City Planning Enabling Act are seen today in the provisions for Planning Commissions that regulate and restrict development by creating master local plans and the controlling subdivision of land. The Standard City Planning Enabling Act assured states that their new zoning regulations would be upheld against any legal challenges sought to prevent overcrowding by reducing density for the purpose of promoting health, safety and welfare (Nolon, 2006).

*The Village of Euclid, Ohio v. Ambler Realty Co.*

Two years after the adoption of the Standard Enabling Act, Zoning was officially endorsed as legal process when, in 1926, the U.S. Supreme Court ruled on *The Village of Euclid, Ohio v. Ambler Realty Co.* The issue began when The Ambler Realty Company filed suit arguing that the zoning ordinance had deprived the company of property without due process (5th and 14th Amendments) after the City of Euclid forbade the developer from building all industrial warehouses where a mixture of industrial, apartments, and duplexes were anticipated. The trial court concurred and held that Euclid's zoning ordinance was an improper use of the police power and was appealed to the Supreme Court.

The Supreme Court Justices agreed that in the Euclid case it is permissible for a jurisdiction to control land use through the police power, and concluded that it could be just as improper to place an apartment building in a single-family residential district as it would be to place a polluting factory there (Nolon, 2006). Where the Standard Enabling Act police powers could prevent a factory from being built in a neighborhood, it could not prevent an apartment building from being built in a single-family neighborhood. Zoning extended the arm of the nuisance laws and the Euclid case paved the way for more widespread use. The Supreme Court's decision places the single-family home at the top of a pyramid, with increasing residential density, then increasing commercial intensity, and finally industrial uses placed at the bottom. The primary purpose of Euclidean is to protect the single-family residential district from encroachment by unwanted uses.

Planners continue to utilize zoning regulations to separate noxious uses and promote compatible uses of land. While Euclidean Zoning has delivered some observable benefits, it is now incapable of evolving with the changes in today's urban landscape. Problems arise when the protection of uses are dealt with by means of design constraints, rather than use constraints. This becomes greatly exacerbated with the struggles of coping with increases in residential density. In the case of residential use, the language is limited by a generalized description of dwelling units per acre (D.U.A), which handicaps the ability of design to act as the mitigating factor for urban development progression.

## The Economic Influence on Form:

Hidden with the proscriptive nature of land use regulation is its close relationship to the financial process of development. Since the United States Supreme Court's decision in Euclid, zoning has placed the single family home at the highest level of protection guaranteeing these homes property values. Because the Euclid ruling is really not that old, we must consider the effect the zoning process has had on neighborhoods that were constructed prior to 1926. There are still many homes –typically within in lower-income neighborhoods- that were owner-built or have had a significant amount of additional construction over its lifespan. The result has been buildings that do not entirely meet today's zoning or building code requirements as they came in under the law (or, more frequently than recognized, illegally). The character of older neighborhoods matured from a relaxed process of self-building over generations largely absent of longstanding financial obligations debt. These neighborhoods of debt-free homeowners have structured their lives around activities of their choosing.

One only needs to consider the irony in the losses in New Orleans. Many of the neighborhoods that literally typified the laissez-faire attitude of the "Big Easy" cannot be rebuilt to today's standards. Even if an outlandish fantasy were to occur where "imagineers" would reproduce the lost neighborhoods of Bourbon Street in prime Disneyland fashion, the costs of doing so would be so high that the demographics of the previous neighborhood would likely change. The non-conformance of these houses make them impossible to mortgage, placing them outside the system that requires a contract of debt, since the new building standards cannot be met without commercial intervention. An excellent summary of how the standardized development process can kill the source of neighborhood character by removing it from its cultural origins from Andres Duany:

> "The hurdle of drawings, permitting, contractors, inspections — the professionalism of it all — eliminates self-building. Somehow there must be a process whereupon people can build simple, functional houses for themselves, either by themselves or by barter with professionals. There must be free house designs that can be built in small stages and that do not require an architect, complicated permits, or inspections; there must be common-sense technical standards. Without this there will be the pall of debt for everyone. And debt in the Caribbean doesn't mean just owing money — it is the elimination of the culture that arises from leisure." (2007)

## The Rise of the New Urbanism and its Link to Form-Based Codes

The past several years have seen the emergence of the Form-Based Code as an alternative means for regulating development. What is considered the first Form-Based Code to be used in the U.S emanated as a byproduct of a private development subdivision known as Seaside, FL. Referred to as The Seaside Code, it established eight building types, regulates yards, building heights and parking much like zoning, but also provides requirements for architectural elements such as front porches and white picket fences (Mohney and Easterling 1991).

Since Seaside, Form-Based Codes have been applied in numerous locations across the country and have become an integral component to the New Urbanist movement. A common criticism for Form-Based Codes is that it typically succeeds under the auspices of a single owner or as a private master planned community. Although it would appear difficult to adopt a Form-Based Code in developed areas with multiple property owners, there are numerous public entities that have done just that, allowing for an alternative that encourages design-based solutions before use-based restrictions.

# CHAPTER 3

## HOW A FORM-BASED CODE WORKS

First and foremost, I would like to address the terminology used in describing a "Form-Based Code". Form-Based Codes often lead the reader to assume that it is a derivative of the common adage "form follows function"; that Form-Based Codes replace land-use as the regulative component with the appearance of a building. This is not accurate as land-use regulation is still included within a Form-Based Code and the level of detail of how a building looks can vary. When looking at what effective Form-Based Codes regulate, other common descriptions that have not caught on such as Context-Based or Transect-Based Code seem be more appropriate.

Form-Based Code is a commonly used term in the planning literature. As such, finding a firm definition of the term is difficult. The Form Based Code Institute, a non-profit corporation that seeks to standardize the practice of form based coding, provides the following definition from their website, www.formbasedcodes.org:

> "[A Form-Based Code is] A method of regulating development to achieve a specific urban form. Form-Based Codes create a predictable public realm primarily by controlling physical form, with a lesser focus on land use, through city or county regulations.
>
> Form-Based Codes address the relationship between building facades and the public realm, the form and mass of buildings in relation to one another, and the scale and types of streets and blocks. The regulations and standards in Form-Based Codes, presented in both diagrams and words, are keyed to a regulating plan that designates the appropriate form and scale (and therefore, character) of development rather than only distinctions in land-use types. This

> is in contrast to conventional zoning's focus on the micromanagement and segregation of land uses, and the control of development intensity through abstract and uncoordinated parameters (e.g., FAR, dwellings per acre, setbacks, parking ratios, traffic LOS) to the neglect of an integrated built form. Not to be confused with design guidelines or general statements of policy, Form-Based Codes are regulatory, not advisory.
>
> Form-Based Codes are drafted to achieve a community vision based on time-tested forms of urbanism. Ultimately, a Form-Based Code is a tool; the quality of development outcome is dependent on the quality and objectives of the community plan that a code implements."

Form based codes seek to avoid the tendency towards a sprawling urban landscape by promoting a revival of the urban design concepts common in cities that pre-date mass subdivision planning (Katz, 1994). These regulatory mechanisms seek the return of neighborhoods designed around a mix of uses, from corner markets and storefront offices to mixed income apartments and single-family homes. The form-based code approach supports communities with a well-defined sense of place.

In the case of Seaside, Florida DPZ (Duany Plater-Zyberk Architects) began at in 1979, the term code to reference all legal restrictions and guidelines applicable to a development: plans, zoning ordinances, design guidelines, and building codes the process of merging these documents into the Form-Based Codes that are in use today.

The first product developed was a series of maps showing the existing conditions of the area prior to development, the planned locations of public and private buildings, the organization of individual lots, and the planned location of each of the eight building types (Mohney and Easterling, 1991). Second, a set of prototypical street cross-sections presented the desired result for six different squares as well as the five types of ranging from avenues to footpaths of transportation corridors (Mohney and Easterling, 1991). Finally, a one-page Urban Code poster produced for the town guided the design of yards,

porches, outbuildings, parking, and building heights for each of eight different building types

In the years since the Seaside code, other Form-Based Codes have taken these elements and created a set of documents that typically consist of five common elements: 1) the regulating plan, 2) public space standards, 3) building form standards, 4) administrative or procedural standards and 5) glossary (Parolek, Parolek and Crawford, 2008). It is generally agreed that the minimum requirement for a Form-Based Code is the Regulating Plan. Without unifying the subdivision laws, providing building typology and a public space plan that standardizes street a Form-Based Code becomes nothing more than just detailed Euclidean Zoning design standards.

## The Regulating Plan

The first and foremost role of the Regulating Plan is to communicate to the public the process to follow in the urban development of the local community. By "urban' I refer to the definition provided earlier to mean the appropriate level of development that remains sensitive to the context of its surroundings. The regulating plan begins first by identifying the location of existing building and street types as the starting point to find what should be preserved and what may evolve. Then the regulating plan continues with the establishment of boundaries between zones of varying urban intensity. These boundaries are applied to a network of streets and blocks (Parolek, 2008).

The most common method for establishing the zones of urban intensity has been the rural-to-urban transect method popularized by the Smartcode, a Form-Based Code tool developed by DPZ Architects and Placemakers, LLC. Where Euclidean Zoning utilizes

zoning districts are organized around statistical quantities of dwelling units per acre (DUA) or floor area ratios (FAR), transect zones are spatially organized the levels of construction, the building type, and the street type. They typically show build-to lines, the locations of civic buildings, and illustrate design features. Because of the regulation of building disposition, one of the first notable differences you will find in a Form-Based Code is that it unifies the land subdivision process to the zoning regulations that are typically separated from a Euclidean Zoning- based development code.

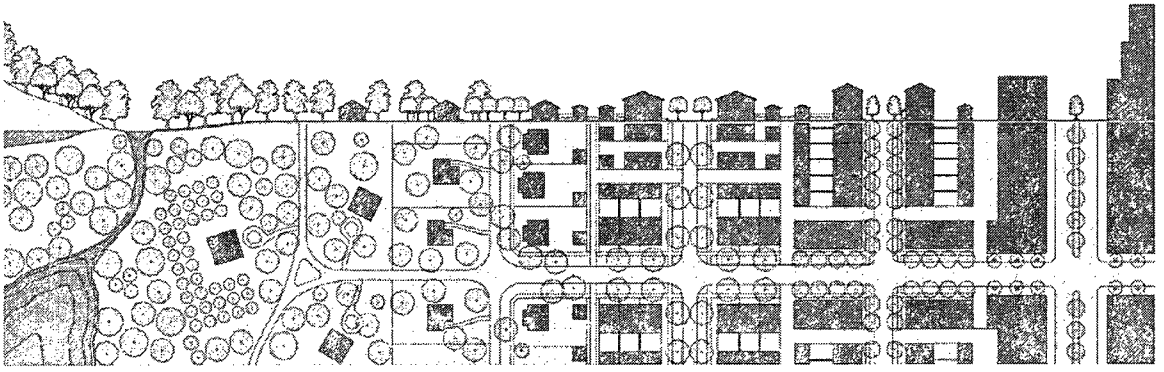

Figure 5. A transect showing the both section drawing (top) and plan view (bottom) of the urban progression from wilderness to urban core.

## Public Space Standards

This section of the Form-Based Code outlines a hierarchy of streets, sidewalks, and paths based upon the street width and level of service within the plan area that is used to determine the applicable standard. Street width, curb height, street-side parking requirements, landscaping and turning radii requirements are then applied to the determined street type.

In addition to the streetscapes, are regulations that address public spaces such as plazas, public parks, and other spaces that qualify as civic spaces (Parolek, 2008). The inclusion of a civic space development standard addresses a common weakness to Euclidean Zoning's qualitative requirements. Park space is generally addressed as an afterthought, since the developer is only required to dedicate open space based on a net calculation. What typically results are "pocket parks" located on leftover lots deemed too unattractive for selling or unfit for development.

Although the locations of trees and other landscaping details related to the streetscape are typically specified in this section, some Form-Based Codes have created separate landscape standards addressing planting requirements separately (Parolek, 2008).

## Building Standards

At the finest scale of Form-Based Code regulation is the portion that deals with the building styles and materials. The building standards provide parameters that are typically illustrated by cross section to specify key dimensions (Katz, 2003). The design standards regarding building height, disposition, elements, and uses are described in the building standards (Katz, 2003) that are permitted and the ways in which they can be incorporated into various building elements such as walls, windows, fences, and roofs. It also describes the ways in which these building elements can be incorporated into different structures. There are other optional standards that may be included such as landscape plans and architectural standards.

Building height is commonly expressed as a maximum height-to-the-eave dimension, or as a range of acceptable number of stories. When building heights are expressed in

terms of one single dimension as they are in traditional zoning, developers attempt to reduce floor-to-ceiling heights to a minimum in order to maximize the number of floors they may build. The minimum number of stories reflects the number of floors required to maintain an appropriate "street wall" (Katz, 2003). A height range is provided to allow for design leeway before it appears overwhelming and out of context in relation to the surrounding community. Height specifications are expressed in terms of two dimensions when using Form-Based Codes (maximum-height-to-the-eave dimension; range of acceptable number of stories). Additionally, building standards may specify minimum above-grade dimensions as they relate to a given typology. For example, a townhome is typically outfitted with a stoop to ensure privacy at the streetfront. This requires the structure to sit several feet above street grade. Disposition regulates the placement of a building in relation to fronting streets and neighboring building lots.

## Administrative Standards

A key part of a Form-Based Code is the portion that regulates its operation. The administrative standards provide a protocol of how a development proceeds through entitlements to permitting. These regulations are coordinated so as to provide quick approvals for compliant proposals and to also allow an appeal process for proposals that are deemed non-compliant at the administrative or staff level.

One of Euclidean Zonings weaknesses is the over reliance on the discretionary review process. For instance, a new development may comply with the allowable use and exceed all minimal requirements of the proscriptive standards but it still requires to be approved by a discretionary review.

## Glossary

A picture may be worth a thousand words, but a word can generate a million pictures. Since a Form-Based Code deals heavily with street and building typologies, a glossary of clear and precise definitions is a critical component. Recall that the original purpose of the code is to communicate the community's process for urban development. The code must provide very specific language accompanied by illustrations for even the most common terms. Confusion often arises from the different meanings interpreted to a common usage whereas the glossary can provide a consistent interpretation.

## Methods of Implementation

Just as important as the Form-Based Code is the means for implementation. Having the best rulebook in the world will not mean much if you do not have a way to enforce it. The ideal condition would be for a local government to adopt a Form-Based Code for its entire jurisdiction. The obvious challenge however, is that it would be overly ambitious to expect the professional development industry to adjust to a reworking of the entire process and it would be cost-prohibitive for the local jurisdiction to completely change over to a very different process. Instead the code may be adopted for a smaller area or corridor and then phased into other areas using similar approaches as needed. The other option is what is known as a floating or optional code that is adopted for large areas. This is usually done over largely undeveloped areas waiting for the public resources to allow the local government to draft its own regulating plans.

### Mandatory Codes

This is the most common adoption approach is where compliance is mandatory. It is also the most ambitious of the approaches as it requires the complete replacement for the existing zoning ordinance. The Form-Based Code can be adopted as a new zoning district or as an overlay district. Some states allow Form-Based Codes to be contained within a planning document called a "specific plan," which completely overrides the zoning ordinance for a given geographic area. Since it stands apart from the zoning ordinance, it tends to vary in its format, allowing for some freedom in designing document's layout. Also, the urban design plan and the implementing regulations are bundled together, greatly improving user comprehension (Parolek, 2008).

### Optional or Parallel Codes

An optional or parallel Form-Based Code gives the developer the choice of the Form-Based Code or the zoning ordinance, but it must be one or the other. The developer has the option of following a Form-Based Code that will streamline and simplify his development process. The challenge then comes from maintaining two different development regulations for one area. Depending on the area being regulated, if some developers are choosing the form-based may lead to a compromised process for integrated place-making (Parolek, 2008).

### Floating-Zone Codes or the PUD Process

Floating zones are most often written to facilitate master-planned suburban communities called PUDs (planned unit developments). However, floating-zone codes

are now being written as Form-Based Codes to facilitate urban development. A floating-zone Form-Based Code does not contain a regulating plan but includes instructions and standards for developers to follow when they prepare a regulating plan for their property (e.g. maximum block dimensions, street types, building types, open space accessibility, and sidewalk widths.) This distinguishes floating-zone codes from the other two approaches–developers rather than the local governments create the regulating plans and the urban designs that they facilitate, but the local government sets the standards. Floating-zone codes allow local governments to establish urban form standards for development without incurring the expense of developing urban design and regulating plans. Developers are given the freedom, within clear parameters, to prepare regulating plans for their property that are likely to meet government approval. A developer submits his or her regulating plan for approval through the rezoning process. Upon rezoning, the floating zone replaces the prior zoning for that property and the regulating plan becomes binding.

# CHAPTER 4

## THE NEW SCIENCES

One of the challenges of this thesis is to aptly reduce the field of New Sciences within manageable parameters. Therefore, the point of this following chapter is to give an explanation of some of the concepts within the field of the New Sciences. There are various strains of thought, systems theory, emergent theory, complexity, evolving systems, and others that all revolve around a common image of a defined system within a given parameter that continuously develops its own organizational structure as a means of adapting to its surrounding environment. An excellent resource in following the developments of the complexity community is the Santa Fe Institute, which was established to offer complex analysis techniques to practical applications. How these concepts specifically relate to the regulation of urban development will be addressed in chapter five. I am limiting the scope of what is often discussed in the field of the New Sciences to three interdependent concepts of system organization that maintain a hierarchical relationship.

Complexity, as the first stage of organization, is treated as the idea of analyzing the amount of order within a given system. Complexity arises when there are multiple processes occurring together. If the processes are disorganized, the processes are defined as chaotic. According to Nikos Salingaros (2006), the complexity of a system can be

measured by the ratio between the number of connections and the number of nodes. Complexity therefore, is a preliminary measurement for quantifying the level of organization. This process is difficult to measure as it and can easily be confused for visual purity (Salingaros, 2005).

From the stage of complexity or a system demonstrating measurable complexity, self-organization can emerge. This would be seen as a complex system that operates under an algorithmic process, a crucial component to understanding and guiding ordered systems towards emergence. Suppose there is a system with N nodes laid out on a single plane that incrementally distributes random pairs of nodes between each link. Even though the placement of the nodes may be random in relation to each other node, there still remains the potential non-random relationship to systems operating at larger scales or other systems present within the same space. In determining the randomness or intention of the node distribution, eventually every node will be connected by at least one path (Salingaros, 2006). There are two available outcomes in this system: a random network, or a scale-free network. In terms of complexity, systems that exhibit a bell curve or Gaussian distribution demonstrate a random-hub network. Contrary to perception, it is less likely that a randomly distributed network of nodes will occur. This is because we do not live in a static, non-interactive environment. We are naturally inclined to favor some nodes over others creating what is known as scale-free networks which behave according to the principles of power law distribution (Barabasi, 2003).

It is important to note the importance of power laws in the description of complex systems as it relates back to the reference made about the algorithmic process. A common explanation for a system with a power law distribution is Pareto's Law, also known as the

80/20 rule. The 80/20 rule stems from Vilfredo Paredo's theory of how the top 20% of individuals hold 80% of the wealth. This rule has been used for various applications, from value engineering to political polling. The key to understanding the meaning of a scale-free system is best offered by Lazlo Barabasi's following rule, "No matter how large and complex a network becomes, as long as preferential attachment and growth are present it will maintain its hub-dominated scale-free topology" (Barabasi, 2003). Because of the nature of the algorithmic process, a self-organizing system makes preferences in its evolution through reiterative and recursive adjustments.

The final stage, emergence, is achieved when the constant reworking of simple solutions within feedback cycles create a complex system that autonomously staves off chaos. Steven Johnson lists the five principle conditions found within systems demonstrating ground-up emergence (Johnson, 2001). The first characteristic is a higher variety in the presence of higher numbers. In other words, in volume comes variety. The next trait is a presence of micromotive and macromotive behaviors. Whether you are looking at the cellular level or you are observing the entire system, a global behavior is apparent. The third feature is the ability to not over-process problems and to leave them at simple algorithms. At the core of highly complex systems are dense interconnections of simple elements making low-level decisions. The fourth condition of an emergent system is the ability to encourage random encounters through decentralizing systems that rely on random interactions (Johnson, 2001). This correlates to the information value of "surprises" as defined by Shannon's *Theory of Information* (Farmelo, 2002) and also works in conjunction with discovering meta-information displayed in reoccurring

information that develops into patterns. Finally, an emergent system utilizes local information to provide global wisdom.

An important goal of this paper is to make the distinction in culturing a self-organizing system, as there has been great confusion regarding complexity theory and its eventual physical expression in architecture. There have been past experiments in extrapolating these scientific theories into a physical representation or the blobs of architecture created using highly complex computer programs that are uniquely distanced from traditional patterns of human activity. Think of an ordered system within an ordered system within an ordered system, ad infinitum much like matryoshka dolls. These Russian nesting dolls fit snuggly within each other but each can each be enjoyed at its own unique scale.

## Communication Theory

For a starting point of the available tools for analyzing complex systems, I offer a discovery that is inextricably linked to the explosive development of the electronic age. In 1948, Claude Shannon published his *Theory of Information*, using a logarithmic formula to predict the quantity of transferable information. Another formula was provided to rate the quality of the transferable information medium. Shannon's work spawned the technological terms we see today, such as the BIT (binary unit), the modem (modulator/demodulator) and was tied to Warren Weaver, whose essay captured Jane Jacobs' attention in the final chapter of The Death and Life of Great American Cities (1992). This relates to the requirement that free-agents have access to information that gives notice to the influence of larger outcomes. Jacobs summarized this with a plea for

planners to seek out the "unaverage" when determining the given qualities of a neighborhood (Jacobs, 1992). The formula, expressed as $I=-p \log 2\ p$ tells us that the amount of information communicated in a message has a measurement of quantity, *I*, with a unit of measurement known as the bit. Despite the enormous impact this formula has had on the world of digital computer processes, this is such an invaluable formula because it is not restricted to just digital processes. The statement made by the equation is that the amount of information depends on the surprise the message holds, or *p*, the probability of a change in the message. For example, you are carrying on a conversation at a party with a friend but your friend is droning on and on. You tune out the familiar until you hear a key phrase –he's going to pay you the $50 he owes you. Surprise represents the unexpected or unaverage events (Farmelo, 2002). The less probable the event the more unique or surprising the event and thus the more information the event holds (Salingaros, 2006)

Another formula that goes with the amount of information communicated is one that reflects the quality of the transmission medium. This formula is expressed as $C=W \log 2\ (1+S/N)$, where *C* represents the amount of information transmitted in bits per second. *W* represents the amount of available bandwidth and *S/N* represents the signal-to-noise ratio. Again, we return to our party but this time it's noisy. Your friend not only owes you money but is partially deaf (his bandwidth, *W*, is restricted). You now must increase your signal by shouting at your friend to overcome the background noise and reduced bandwidth (Farmelo, 2002). What this formula provides is a general application for determining the quality of a transmission of information. Nikos Salingaros, and other mathematicians have begun applying these formulas for determining the amount of

available information that a building can transmit through the expression of ornament, tectonic features, and scale.

## Logarithms and Networks

The next step is to address the application of the new sciences to "inform a process of city-making, and the role within it of methodology, pattern, and precedent –all those things related to Jacobs" (Mehaffey, 2006). The most beneficial contribution that the new sciences have made to architecture and urbanism is the progress towards integrating mathematical qualifications. We have formulas that can provide results reflecting given quality and resolution. These formulas can be adapted to policy recommendations that help planners clear the hurdle of quantifying data into ratios that describe no special occurrence or relay no quality. The most important habits of thought, according to Jacobs (1992), are to remain cognizant about the process and to work inductively, reasoning from particulars to the general, rather than making deductive generalizations. Jacobs encourages to seek "unaverage" (or unique conditions/events) clues involving very small quantities, which reveal the way larger and more "average" quantities are operating (p440). This correlates to Shannon's Theory of Information, that the unaverage conveys information by the probability of surprise (Farmelo, 2002).

## Scale

Scale is best defined as all elemental components having a relatively similar size within a given parameter. Smallest scales should link their way to the largest scales. A mathematical formula for verifying scalar dimension is $p=c/xm$ where $p$ denotes the multiplicity of elements. $M$ is an empirically determined value between $1>m>2$ and c

represents a constant. The more levels of scale, the more structural entropy –or the increase in the average amount of information (bits) needed to quantify the amount of uncertainty of a given variable (Salingaros, 2006). In other words, the more scalar levels, exhibited, the more information provided.

## Fractals

A method that combines the concepts of scale and the medium of information transmission into a tangible process can be done with fractal geometry, a popular method in understanding organized complexity. In producing fractal geometry you are provided two options, composition or decomposition. Both of these represent an opposite process of order hierarchy. Decomposition is the application of an algorithm that continuously divides up a given geometry into smaller parts and continues this reiteration until the complexity limit has been reached at the smallest scale of object we can possibly make (Eglash, 1999).

The other method, composition, continuously multiplies the initial geometry by applying a reiterative algorithm that grows the fractal outwards. If we look at this compositional fractal we see that the scale of the structure composed to the initial geometry increases exponentially with the largest structure coming last. A new line is written for each reiteration of the algorithm on the previous line (Eglash, 1999). The complexity of the structure only becomes visible when the time dimension is displayed. At their local scale, the cells are not able to "see" how their actions create the system, but their actions do in fact make something bigger than themselves. They are creating a structure by emergence and this emergence is visible only in a dimension larger than their

actions: the emergent dimension. The difficulty stems from an established reasoning for emergent systems to be based on a compositional system.

## Scale-Free Networks and Power Laws

Failure in creating a successful network comes because a high degree of geometric regularity is forced (Salingaros, 2006). From the view of a map, this looks visually appealing it is insensitive to the three elements of the network as just described. Highly complex patterns of activity cannot fit within neat, simple, geometric forms. Indeed, the network may look organized yet be disconnected and conversely, may look disorganized yet be highly connected and functional. The connections of the network should be multiple and irregular. In mathematics, there is a theorem, which states that two points can only be connected in one way by a straight line, but in infinite ways by curved lines. Therefore, in order to increase the number of connections between points, curved connections must be used. A principle of physics states that the interaction between two objects can be written as the sum of interactions over all possible paths between them. Multiple connections serve a functional role too because they reduce overloading on singular connections.

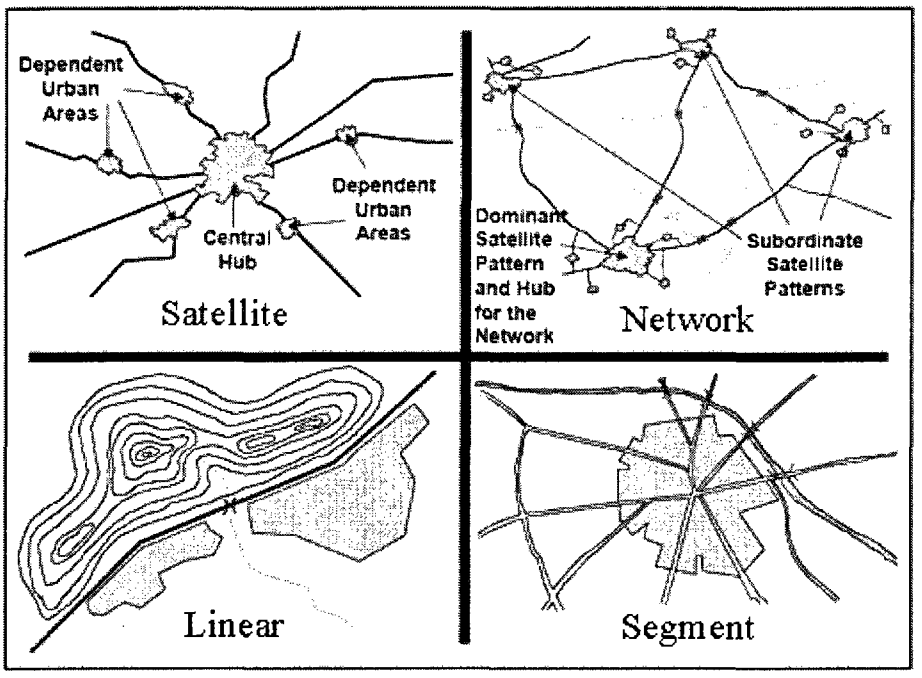


Figure 6. Types of Urban Patterns (*U.S. Army Field Manual No. 3-06*)

As mentioned earlier, let us suppose there are N nodes laid out on a plane. By adding connections between random pairs of nodes incrementally we will have every node connected to every other node by at least one path. The point at which this happens can be viewed as a phase transition of the system from a disorganized state to an organized state. The application of Salingaros' adaptation of Kevin Lynch's three principles of nodes, connections, and hierarchy gives rules for how to build better neighborhoods (Salingaros, 2005). In order for connections between nodes to be used, there must be complementary uses for the nodes. This can be explained using a principle from physics that describes how electrical or fluid flows only between points of differing potential. The nodes, with a sufficient density present, will incur motion between areas of differing intensity in use or function. Multiple paths for walking are created naturally between

complementary nodes when there is enough density with some paths to like nodes eventually merging. The important point is that uses must be mixed in order for the connective process to begin.

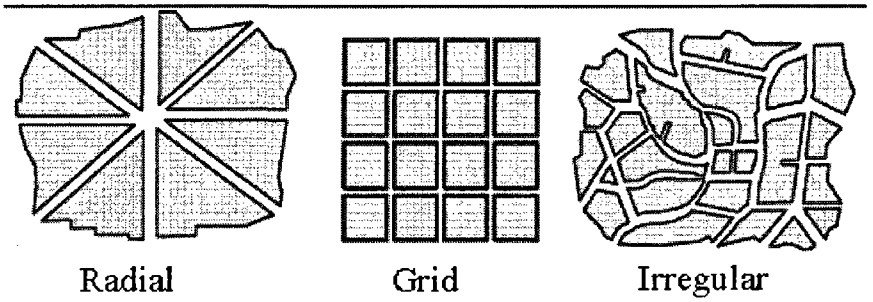


Figure 7. Street Patterns (*U.S. Army Field Manual No. 3-06*)

The shortest distance between point "A" and point "B" is a straight line. Therefore, since people tend to walk the shortest distance, the connections between nodes should be straight. This doesn't contradict with the previous statements that connections should be curved because another mathematical result states that any global curve is locally straight in the limit of small measure. In other words, the path may be straight in the short distance between two complementary nodes, but curved when looked at from a distance (Salingaros, 2006).

Given the hierarchy of the network, it is necessary for the networks at different scales to connect to each other. However, they do not have to coincide or be joined together.

Cross-connectivity results in a stronger web and also eases congestion when compared to a system with only one network.

The theory of the network is organized around the principles of nodes, connections, and hierarchy. These principles, coupled with mathematical theories, give guidelines for good urban design with the ultimate goal of organized complexity. One way of measuring organized complexity is the pattern measure, a technique used by Nikos Salingaros that gives an idea of the liveliness of the pattern as perceived by people. The pattern measure can be extended to determine the organized complexity of larger grids and can also be applied to architectural forms. It captures the information inherent in a pattern and expresses it in a way that corresponds to our intuitive notion of life or complexity in a pattern.

## The Algorithmic Process

A starting point in applying the algorithmic process is to begin by looking at the types of problems there are and how they address different aspects of the issue. From the understanding of the types of problems there are we will make a large leap into how the problems may be addressed in an ongoing fashion by means of rule making and defining problems in the context of game playing. I begin by looking at the types of algorithmic problems presented by Gregory Wetzel and William Bulgren in *The Algorithmic Process* (1985). For this paper, the nature of an algorithm includes the process of recursion so that is takes a problem, provides a solution, and incorporates that solution into the next problem –for as long you wish to continue that cycle. By "problem" I mean when a

desired goal is not immediately achievable or the means for obtaining that goal is not obvious.

According to Wetzel, there are two ways of categorizing problems. There are informal problems, where the solution is not found by precisely specifying the initial conditions, the desired results, or the actions by which we achieve those results. Informal problems may not even appear as problems and are not within the scope of this paper. My focus is on formal problems, which are characterized by thorough specifications and precisely defined initial conditions that lead towards a solution of a specified form. The distinction between informal and formal problems is between the procedure used to solve the problem and the actual results obtained by using the given procedure to solve a specific instance of the problem (Wetzel, 1985). For instance, X is a problem because we desire Y as a result, without knowing how to get Y with any certainty. The result is that you essentially put faith in a system that you believe will deliver certain results without having a full understanding in the operation of that system. The goal is a general understanding of the system so as to deliver predictable results; to reduce faith and increase certainty. From problems classified as formal, there is the further distinction between problems of analysis and problems of synthesis.

Problems of analysis are those in which we know the starting point and the ending point, but we do not know how we get there. That means that the problem really deals with creating a process to get us from the initial condition to the final results. This is best understood with the space program sending men to the moon. These are what I would call garden problems; the challenge is to discover the rules that guide toward ongoing additions and manipulations. The continuous act of urbanism fits within this purview.

Conversely, problems of synthesis offer specific initial conditions and specified plans of action, but only specify a general form of the result. I equate these to the mechanical problems that try to solve two-variable problems. This compares to Jane Jacobs' description of Warren Weaver's two-variable problem of disorganized complexity (1992) or what we see today in conventional suburban development. A singular act of architecture fits within this purview.

By comparing these two types of problems to James Carse's work described in his text, *Finite and Infinite Games* (1986), there is a strong similarity. Problems of synthesis are similar to the requirements for classifying game as finite and the rules based upon such game. Finite games seek a resolution of problems in a strategic manner that advances the game player. In this case, an act of architecture is the resolution of a problem, a singular event. The act of adaptation –by means of adding, removing, or any alteration -of that initial architectural move becomes a problem of analysis. For example, when a building is completed, it represents a turn taken in a game that other players must respond to in order for that game to continue. If the players choose to ignore this move, the context, and thus the game, grows weaker. And within that break in context is the introduction of more "noise" that inhibits the clear communication of informational network displayed in the physical representation of the block or neighborhood.

# CHAPTER FIVE:

## ORGANIZING BY FORM

Building upon a general understanding of what the New Sciences offer and how the Form-Based Code works, I begin this chapter by looking at my earlier proposal of adapting the synthetic and analytic algorithmic processes to finite and infinite games (problems = games). When we look at urban problems as games then the development codes become the rules (Carse, 1986). This allows building proposals at various scales to be handled as strategic moves towards creating a coherent city as an ordered form. The idea is that informational cues that establish the context of a given area are always kept in play when determining the approval of a building proposal.

The purpose of this argument is to demonstrate the philosophical disconnect that land-use based planning has, by definition, to the concept of *telos*, something with an end purpose. Compare this to how a Form-Based Code is structured to coordinate the construction of a building, a neighborhood, and eventually a city as its final purpose. The action of realizing a teleological purpose is through the production of an object or accomplishing a goal or method known as *techne*. From an ontological perspective of dealing with physical things, Form-Based Code regulate the creation of physical things - albeit with qualities that transcend physical existence- developed by rational means, or techne. The Form-Based Code provides rules for the development of the urban

environment by staying within a context of tangible elements or the nature a city. The parts that are effectively regulated are the parts that communicate the information of the environment. The streetfronts, the building placement, the accepted ranges of building typology all frame the urban conversation to what is currently accepted and what are the acceptable levels of change. Every neighborhood or block will go through a phase transition from one transect to another. What becomes important is that the dialogue remains consistent with the general expectations of the local residents.

Euclidean Zoning fails to adequately describe the nature of a given environment at the finer scales of buildings and neighborhoods. At best, land-use operates from a generalized quality that may describe a type of district, but functions poorly when used without a language that regulates the type of building within a type of neighborhood. Rather than placing emphasis on the uses of a given building or district, the idea is to explain how the city is a scale-free system by, ironically, looking at the various scales of the urban environment. By scale-free, I mean a system that can be identified by the reoccurring patterns of fractal joints described as follows: tectonics define a building; building type makes the block; the streetfronts of the blocks make up the neighborhood; and the neighborhoods make the districts and/or city. At any scale, these are all singularly operable components, but they also work as coherent whole.

For example, beginning at the scale of the individual building and how it relates to the larger scale, we can take the systems approach in demonstrating the association that the sidewalk has at multiple levels of urban development. From the sidewalk level, the detail in building construction is best understood by the passerby to a level of interpreting the local construction methods and materials, which in turn supports the heritage of a given

building. This is done from a public right-of-way that is utilized by all people, from those in strollers to those in wheelchairs, from those who want to window-shop to those whose only means of transportation is a pair of shoes. The sidewalks have multiple roles in the success of a neighborhood from the civic, to the private, to the public.

There is an important aspect when discussing whether cities are actually emergent systems and that is the hierarchy of the process of self-preservation. The emphasis of bottom-up emergent systems is that there is more adaptability, as there is no focus of centralized directives (Johnson, 2004). There is a trade-off in that one may encourage insurgent actions in order to maintain lower level survivability. Cities develop from different layers –two specifically. First, you start at the local jurisdiction's authority for recognizing the subdivision of property that a constructed project occupies. The second layer represents the private individual whose development proposal occupies the regulated land. It is the government that establishes real property and in effect, creates the boundaries of the project. The regulating plan within a standard Form-Based Code requires that the subdivision process be carefully integrated within the establishment of the code. The plat-sections will still remain as the initial organizing component of a city, but can now act more as a lattice work for urban structures to "crystallize" upon.

## The Fractal Nature of Tectonics

The first level of architectural exposure, referred to here as the tectonic, is where the enthusiast and the specialist can hold a discussion in absentia. As the enthusiast begins to look around he generates questions in his head as to how or why the building was formulated in its given manner. The specialist's work in a good project will respond for

itself. Even in our contemporary collective short attention span, a good building will demonstrate how it operates thus providing a positive cultural contribution to be followed. This is because the building will first be used, then enjoyed, and finally protected, thus becoming an integral piece of urbanism. This connection is best explained by Kenneth Frampton and his view to include an evaluation of construction method in addition to spatial qualities, "...the unavoidable earthbound nature of building is as tectonic and tactile in character as it is scenographic and visual, although none of these attributes deny its spatiality. Nevertheless we may assert that the built is first and foremost a construction..." (Frampton, 2001, p. 2) We can enjoy the building for its every day utility while also enjoying some poetic moments that it may offer. Oddly enough, the areas where the building is connected, either to itself or to its site, communicates information that one derives cultural meaning from.

However, meanings do change over time; today the word threshold seems to have more to do with some sort of regulatory trigger than with the bottom of a doorway. In an effort to avoid the loss of tectonic meaning we look at the preservation of traditional building craft through the constant rebuilding of the Ise Jingu Temple in Japan. Because of the complexity of the Jingu Shrine's construction, the Japanese created a devout carpentry culture, known as *kiwari*, that selectively hands down from generation to generation the knowledge of 400-plus different types of joints known as, *kigumi*, seen in the construction of roof trusses and frames (Seike, 1997). One reason for rebuilding is to guard the collections of kigumi from other carpentry guilds while keeping future generations informed on how to carry on the craft. By creating a process that teaches the special techniques to a new generation every twenty years, a social connection is rooted

in these kigumi. These joints of the Ise Temple are the cultural signatures -or what Richard Dawkins calls "memes"- that connect an individual to a larger community. The physical connections and separations of the kigumi not only carry information on how the building is constructed, but also provides a view into who was the builder (Seike, 1997). The relationship of kiwari to kigumi calls out a common struggle in the preservation of tradition: on one hand there is the desire to preserve the artifact by avoiding any potential degradation. On the other hand is the sacrifice of artifact at the hands of understanding its construction through rebuilding.

## The Fractal Nature of Typology

Just as the tectonics of a structure presents itself to the individual who experiences it, so too does the disposition establish the character of its typology and its relationship to the neighborhood. The key benefit of building typology to urban design regulation is its ability to adapt to changes in context where land use cannot. For example, a block of two-story brownstones would be equivalent to a block of garden apartments in the eyes of land use.

Typology is situated in a regulatory class between tectonics and borders and acts as the second stage of an ordered system that is bound by neighborhood or district defining borders. With regards to the form-based code process, typology covers not only the general form of a structure but also provides a functional range of uses that may occur within the building class. There are three consistent items to a well-defined building typology: its function, its configuration, and its disposition. These three items are at the core of a typology that transcends style and in general vernacular. For example, imagine

the typology of a "firehouse" and then picture it being finished in a Southwest Contemporary, Cape Cod, or Colonial style. Each of the styles represents the same building but is finished in a vernacular that controls its suitability to a given context.

In order to establish an effective building type, the function should be declared within a range of general activities that can occur within the given building type. The configuration of the building type is the normative three-dimensional arrangement of spaces that are customary to the building type. The disposition is the crux of the building type and the part that keys into the characteristics of neighborhood's borders and a building's joinery. Disposition, like a tectonics, has a double acting nature that is best described with the verb "to cleave". "Cleaving" describes something that is both being cut apart and being pushed together (Duany, Morissey, Pinnel, 2006). By viewing the disposition of a building as an action that both separates and adheres, this important aspect of typology serves a feasible method for addressing the concerns a building and its anticipated use will have on its future neighbors.

## The Fractal Nature of Borders

Euclidean zoning, when applied at a large scale, can create a border by creating an obstacle to the traveler. What is hard to distinguish is that there is an inherently destructive result in this large expanse of blocked passageway. Jane Jacobs offers a two-sided, interrelated rule of land-type division to not only to identify a border, but also recognize hindrances and catalysts to foot traffic. As stated by Jacobs, "...general land is used for general public circulation by people on foot... special land, is not commonly used as a common thoroughfare by people on foot" (Jacobs, 1992) This is important as a

beautiful subdivision with thick, lush landscaping can be just as much an obstacle to the pedestrian as a wall of warehouses or a waterfront. The idea is to recognize the scale of the obstacle. If one is stuck running alongside a perimeter wall like a rat, making it glamorous does satisfy the initial condition of feeling trapped.

## The Nature of Urban Networks

Kevin Lynch's *The Image of the City* (1960) is a good resource for establishing the awareness of an obstacle that can be hard to distinguish. For instance, a lead paint factory and a schoolyard would obviously need some type of barrier. But there is also the need, at times, to provide a border in order to distinguish similar items. In the creation of districts, a border may be used to create neighborhood identity not out of the need to protect itself from other neighborhoods, but as a means for staying sensitive to nature of contextual development. It is also important to note that connections are strongest between complementary nodes such as home and work and weakest between similar nodes such as home and neighbor (Salingaros, 2006). When borders are established, they should still remain sensitive to the networking requirements and allow pedestrians to go through, otherwise connections will be severed. Connections cannot be supported when nodes are too far apart on the landscape. Good urban places meet the general conditions for what is pleasing, healthful, and harmonious and follow the rules and patterns that are mathematical in nature (Salingaros, 2006).

Since I am validating the potential structure within the Form-Based Code regulatory method using the principles of the New Sciences, I will review the concept of a networked system in terms of an urban grid. First, some background on the components

of an urban network as described. Although there are distinct differences between a dense city like Tokyo and a sprawled out city such as Atlanta, all urban areas can be categorized under a general urban pattern and a network pattern. The network patterns of streets historically are a resultant of the urban pattern. The general practice was that the streets would navigate around the buildings so that the resulting pattern would be described as "all roads lead to Rome" - not through Rome. However, the issue is not whether it was the streets that brought the buildings or the buildings that required the streets. In both instances, the result is still limited within the parameters of form. Street widths and the establishment of rights-of-way operate within the given urban pattern as a means of supporting its future growth and/or refinement. A city cannot exist without its streets but a road can continue on without a city.

The easiest method for establishing a healthy urban network can be done under a simple process that is aligns neatly with the typical quarter-section layout mentioned earlier. This process is accomplished by scaling the neighborhood block, the secondary scale of regulation in a Form-Based Code after the building, and the first scale of urban development, at a size no greater than a five-minute walk. This time-distance calculates to a quarter mile, as this give a generous average walking speed of three-miles per hour. The resulting block size, when adjusted for public right-of-way, equates to approximately 300 to 400 feet in length. An interesting side note is that the five-minute walk adjusts perfectly to the township diagram established by the Continental Survey in 1803 (Duany,Plater-Zyberk, Alminana, 2003).

# CHAPTER SIX

## SUMMARY OF ARGUMENT AND RECOMMENDATIONS

There are flaws that become apparent when trying to resolve detrimental urban issues in terms of sustainability. For example, currently there are many problems that are being discovered from a hydrocarbon-based transportation system (gasoline-powered cars). If a no-cost petroleum replacement garnished with the ability of zero emissions was discovered we could sustain our fleet of private motor vehicles. But would sustaining the dependence on cars resolve the health issues from too much driving, the inequity in accessibility to those who cannot drive, or the inefficient land use patterns based on car-enabled sprawl? Trying to put a shrunken bed sheet on a mattress illustrates the difficulties in dealing with problems of complexity. For instance, if you continue with making your bed accustomed to a sheet that used to fit, you will become frustrated by the sheet's ability of covering a few of the corners of the mattress. The bed sheet, in its shrunken, no longer works. Between making an adaptation (e.g. stretching the sheet) or a reworking of the process (e.g. making your bed with a new sheet) are the measurements of efficiency –with the utilization of the smaller sheet being highly efficient and replacing the sheet indicating low efficiency. Additional variables surface over time and must have a way of being worked into the process of solving a problem.

## Administrative Review Process

The Form-Based Code process represents an adaptable method. The change in the form of the sheet requires it to be reworked in order to fit the mattress; our use-based approach no longer recognizes the resource of the shrunken sheet –as a use, it is now a sheet that accommodates a smaller mattress.

Probably the first and foremost requirement to a Form-Based Code process that must be included is the requirement of a streamlined administrative review process. The greatest advantage of a Form-Based Code and its use of building and street typology is that the bulk of publicly contentious issues have already been resolved. A proposed building must be in significant compliance with the regulating plan of the code in order to submit for the administrative review, so there would be no beneficial purpose in wasting time with a the public hearing process. If the proposed building could not comply with the code requirements, it would still move forward in a request for entitlements at the public hearing level.

## Generalize the Land Use

The next obstacle to an effective Form-Based Code is inclusion of permissible uses. Land use regulation is not abandoned in a Form-Based Code, but it is relegated to broader categories. The reason is that the form of a building can more aptly govern the use of a building than use-restrictions alone. If a property owner were to own a 2,000 square-foot corner market, its typology would prohibit him from trying to operate a movie theater. In the eyes of land use, they're both the same. So what must be avoided is an overloading of specified land uses that restrict the flexibility of the building form.

A Form-Based Code does not have to operate as a top-down mandate with little enforceability. Rather, it can be a locally-adopted regulation with the same police powers used by the land use regulations to undermine urban form. It is crucial that the ground-level component of the urban engine -the community at large- partake in the creation of its own rules. The community has the potential to play a greater role in shaping its physical future than it does with the Euclidean Zoning in two ways. First, the street and building types are determined in a charrette-led public process to establish the context of the neighborhood and to create a vision of what residents want their neighborhood to be. This is the chance to eliminate the constant surprises, as nothing can really be anticipated in Euclidean Zoning other than the function of the building. This initial hurdle may burdensome, but it is nothing compared to the constant revisiting of non-compliant requests heard at every planning commission. And as these requests become approved, it continues to be challenge the identity of what the neighborhood is trying to be. Because the public hearing process is reduced from hearing all compliant requests, the public can provide more focus on the requests for deviations from the code.

## Streamline Community Feedback

I would suggest looking to the recent development of web-based community design businesses as a possible resource in the organization of low-level feedback for building proposals. One such company, at www.Threadless.com, creates t-shirts based on online submissions that win the online popular vote. Another similar company, www.Ryz.com, follows a similar process but with sneakers. Both companies provide the template that an aspiring designer downloads, decorates, and then uploads the design to

be displayed along with other choices to be chosen by online-pollers. When the t-shirt or sneaker design is chosen, the winner then receives a cash prize/reimbursement. It would be interesting to an adaptation of this process so that opposed building plan and elevations were provided in some way that the neighbors of the local community could have input included and documented during the administrative review period.

## Grow Incrementally

One of the last recommendations that I feel is a necessary component to an effective Form-Based Code is the ability to development incrementally. Just as it is important that a Form-Based Code quickly deliver construction entitlements, it must also be able to regulate the speed of actual construction. An important aspect of an organizing system is synchronization. The timing of a system's growth cannot outpace the maturation of the newly developing portions.

One of the Christopher Alexander's key requirements listed out in his *New Theory of Urban Design* (1987) is a step for incremental development. I have yet to see this called out specifically in any Form-Based Code, and would need to be included in order to operate under the auspices of a strong systems generator. If we were to base the maximum size of a development to the minimum practical scale of the code, the block, I would recommend that the ideal block size fall within the 300-400 foot length (or at least a 1200-foot perimeter) as dictated by scaling of the five-minute walk, commonly calculated out to a quarter-mile. This equals, roughly, a 2-acre maximum development size. An interesting note for those that insist that a 2-acre development cap as completely impractical: The Sears Tower occupies just one 300-foot block in the City of Chicago.

Large-scale projects could still receive entitlements for a forty-acre development but it would not receive permits until each 2-acre phase reaches a stage of completion. A certificate of occupancy would not be issued prior to the next 2-acre development receiving permits to start grading.

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# VITA

Graduate College,
University of Nevada Las Vegas

Michael Howe

Local Address:
1313 South 15th Street
Las Vegas, NV 89104

Degree:
Bachelor of Arts, Political Science, Cum Laude, 1999

Special Honors:
Graduated with Department Honors
Phi Kappa Phi
Golden Key National Honor Society

Thesis Title: Organization by Form: Applying Systems Theory to Urbanization.

Thesis Examination Committee:
Chairperson, Robert Dorgan, Associate Professor
Committee Member, Kevin Kemner, Assistant Professor
Committee Member, Glen NP Nowak, Assistant Professor
Graduate Faculty Representative, Dr. Robert Futrell, Ph. D., Associate Professor