## The Anatomy of Sprawl

### Synopsis

Imagine a physician who has never studied human anatomy. He knows the common medicines that all the doctors use, the usual tests that everyone orders. Like an actor on "ER" he yells "CBC, chem 7, *stat*, bag him", but he does not know how to interpret the test results and he cannot understand why the patient recovers or dies.

We know more about the complex systems of the universe than we know about the formal growth and change of our own cities. Planners and designers offer medicine— "new waterfront! streetscape! design guidelines! *stat,*" but may have only a folk theory of how these interventions actually operate.

The first part of the following article describes an original thesis on the basic elements of urban form and uses it to analyze some physical issues in suburbs. Unlike human bodies, cities are greatly varied in their physical form. In order to study them comparatively, we need to establish a system of analysis that breaks the physical city down into fundamental elements that are found in all cities, regardless of their location, history and culture. The study of the city as physical form is called urban morphology. While the framework of analysis that is described in this article is new, it relies on the insights of urban morphology scholars over many decades.

Most urban and suburban areas grew in an unplanned manner from tightly planned urban cores that are now miniscule in comparison to the overall city extent. The site and pre-urban structure (e.g., farm roads, fields) are highly predictive of the subsequent patterns of urban growth, and they continue to shape urban change, even though their initial use as country roads and cornfields is long past. This article uses a case study of a typical suburban town southeast of Cleveland. The town of Hudson, Ohio, was established in 1799, but was a tiny village until its recent suburban explosion.

This article traces the history of Hudson's formal transformation while introducing its various formal layers and their relationships. Hudson's pre-urban cadastre is a standard township grid, common to most of the western United States. The chapter demonstrates how the earliest layers, the site, the pre-urban cadastre and pre-urban paths, substantially constrain and shape subsequent development.

## Introduction

The purpose of this case study is to examine the anatomy of suburban growth patterns of the last fifty years. The working hypothesis of this research is that suburban growth develops in patterns that are strongly conditioned by the pre-urban fabric, for example, the farm roads and fields that pre-date all other development. These original, rural patterns can generate extremely scattered and disordered environments, which are difficult to plan or change because they are structurally flawed.

This study uses methods of urban morphology, or the study of urban form, to analyze the development of a suburban area over time. The area selected for study is Hudson, Ohio, which is an independent city/township situated between the larger urban areas of Cleveland and Akron. Although Hudson has an historic village center that is almost 200 years old, its recent growth has far overshadowed the first 150 years of its existence. The 1995 population of Hudson was estimated at 21,000 persons, compared to a 1950 population of 3,000. (Plfum et.al. 1995).

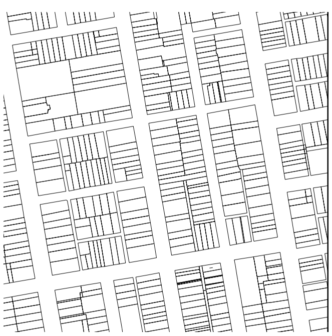
Hudson is a relatively independent suburb that is not an extension of an urban core, but lies between two urban cores and has its own village center. As a case study, it is interesting because records of its first and subsequent occupation are quite complete. Hudson is finely delimited by the township borders and its original checkerboard pattern. Hudson's atypical awareness of its place in history has left an immense legacy of documentation of the town and its architecture, while the preservation efforts themselves have affected only a tiny part of the township. Finally, Hudson is also a well-to-do city which supports complete computer documentation of its current records including GIS mapping and digitized aerial photos.

In order to unleash the power of urban morphology, methods have developed that allow comparisons between different places and between the same place in different time periods. Morphological analysis begins with scaled maps, which abstract and single out the formal components of the city so that they can be read more clearly.

What are the important physical components of the city? Traditionally, urban planners treat the city as a functional object, classifying areas and corridors by their *use*. The most common breakdown is land use, which describes the activities of humans on the land. Land use is complemented with a transportation or access map, which is another way of showing human activities. While these are two important tools, they are not very informative about the actual physical character of a place. Areas marked "residential" on the land use map may be small houses, large mansions, or apartment buildings. “Commercial” areas may be corner stores, malls, or a gas station. Although there is a relationship between form and function, the form of something may not be presumed by its function.

Sometimes form and function are so closely related that it is conceptually difficult to separate them. For example, when we see a house, it is difficult to conceive that the form of the building is one aspect of it, and its use as a residence is another. Yet, one need only recall the many occasions when old houses are re-used as office buildings or restaurants to see how the house *form* is not married to the idea of *residence*.

On the urban scale, it is sometimes useful to set aside the actual function of buildings (which can change very rapidly, in any case) in order to discover more fundamental physical patterns. The physical nature of different residential neighborhoods may be quite distinct, because of the use of different patterns of streets, different basic building types and different scales. These differences may indicate that the neighborhoods were built at different times and it surely indicates that they house different economic groups. Uncovering and analyzing these patterns, types and scales, their changes over time and their relationship to other facets of the city (demography, history, economy) is the basic task of morphology.



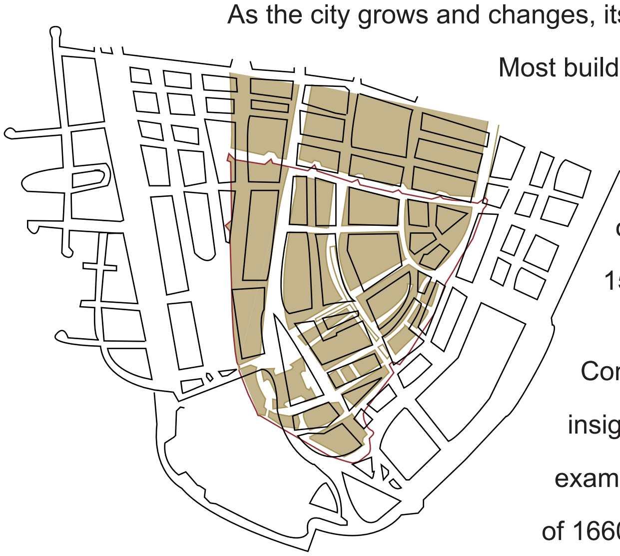
The basic components analyzed by all urban morphologists are the land subdivision (known as plots or lots), the buildings and other structures, and the streets. In the urban landscape, these are variously combined to form larger components such as blocks, districts or tissues, and regions. Land subdivision is, of course, not a tangible object the way that a building or a street is, nevertheless the spatial order of a city is highly dependent on land subdivision and land subdivision is usually revealed through physical components like fences, roads, and hedges.

The spatial and physical systems of the city that have previously been identified by Caniggia and others, are usually arrayed by their relative physical scale hierarchy, that is, a building is smaller than a lot, which is smaller than a block, and so on. (Kropf 1993, Moudon 1986) . Especially in the model developed by Caniggia and Maffei (1979), there is the concept of a nested hierarchy, that is, the larger parts are composed of aggregations of the smaller parts. This model of morphology lays an emphasis on the building type, especially the dwelling unit, as the defining element of urban form: it is the “cell” out which the structure is built. This model, developed especially to understand traditional European cities, presupposes a strong relationship between the fundamental types and the lots, blocks, and streets.

In many modern parts of cities, though, the form of the city is much less dependent on the form of individual building types. In the modern city, the type-lot-street relationship is much less defined. Lots may be very much larger than the standard types, giving substantial "play" to the site plan possibilities on a particular lot. (Think of the standard "big box" type, floating indefinitely in its parking lot). The lots are not necessarily arranged in geometrically defined blocks. Street patterns are whimsically related back to the building type. The disengagement of building-lot-street is especially obvious in commercial strips or industrial areas. Even in cases where individual building types substantially explain certain patterns, it is clear that the city is composed of many other elements which would be overlooked in this model, for example, parking lots, lawns, bridges, signs and rivers are physical elements which are not necessarily linked in form to elemental building types.

To understand the complex relationships between these disparate forms, I have turned to a model that ecological scientists use to study a complex eco-systems. In this model, the various physical forms are organized by the rate at which they respond to stimuli, in other words, *the rate at which they change*. "For example,  individual tree leaves respond rapidly to momentary changes in light intensity, CO2 concentration, and the like. The growth of the tree responds more slowly and integrates these short term changes. Change in the species composition of the forest occurs even more slowly, requiring decades or even centuries."(O'Neill, et.al. 1986, 76). The growth of the tree itself responds only to very broad climatic shifts, not daily or hourly dosages of sunlight. The leaves and the tree respond on entirely different *time* scales, with the leaves changing in a matter of minutes while the tree makes slight annual or seasonal adjustments.

As the city grows and changes, its physical components also grow and change at different rates. Most buildings endure between 100 and 300 years. In the intervening years, a single building will be added to or altered by its inhabitants and owners many times.  On the other hand, a street tree or a road sign normally has a shorter endurance, lasting perhaps 15 to 20 years or even less.



Comparing old and new maps of any city reveals an interesting insight: the streets and public ways of a city are very persistent. For example, compare the map of lower Manhattan made in the summer of 1660 with a tourist map made in 1997.   Almost every street in the tiny colony can still be traced in today's world capital of high finance. "Wall Street" was literally a wall, one of the few built in North American cities. The same phenomenon can be observed in much older cities, like Florence and Cologne, where 2000 year-old Roman street plans peek out from behind a curtain of accumulated medieval and Renaissance buildings.

The physical components of the city can be arranged into three broad groups that represent their average endurance: the *site* of the city, which changes on a geologic time scale; the *buildings* and other durable structures, with an average endurance of 100 to 300 years, and a large group of *objects* with a shorter endurance, like lawns, street paving and utility poles. Endurance here means the actual life span, not the expected life span of an object before it begins to deteriorate. Deterioration is only one of many reasons that an element may be removed or replaced. Mechanisms of change that do not involve deterioration are also important in the city.

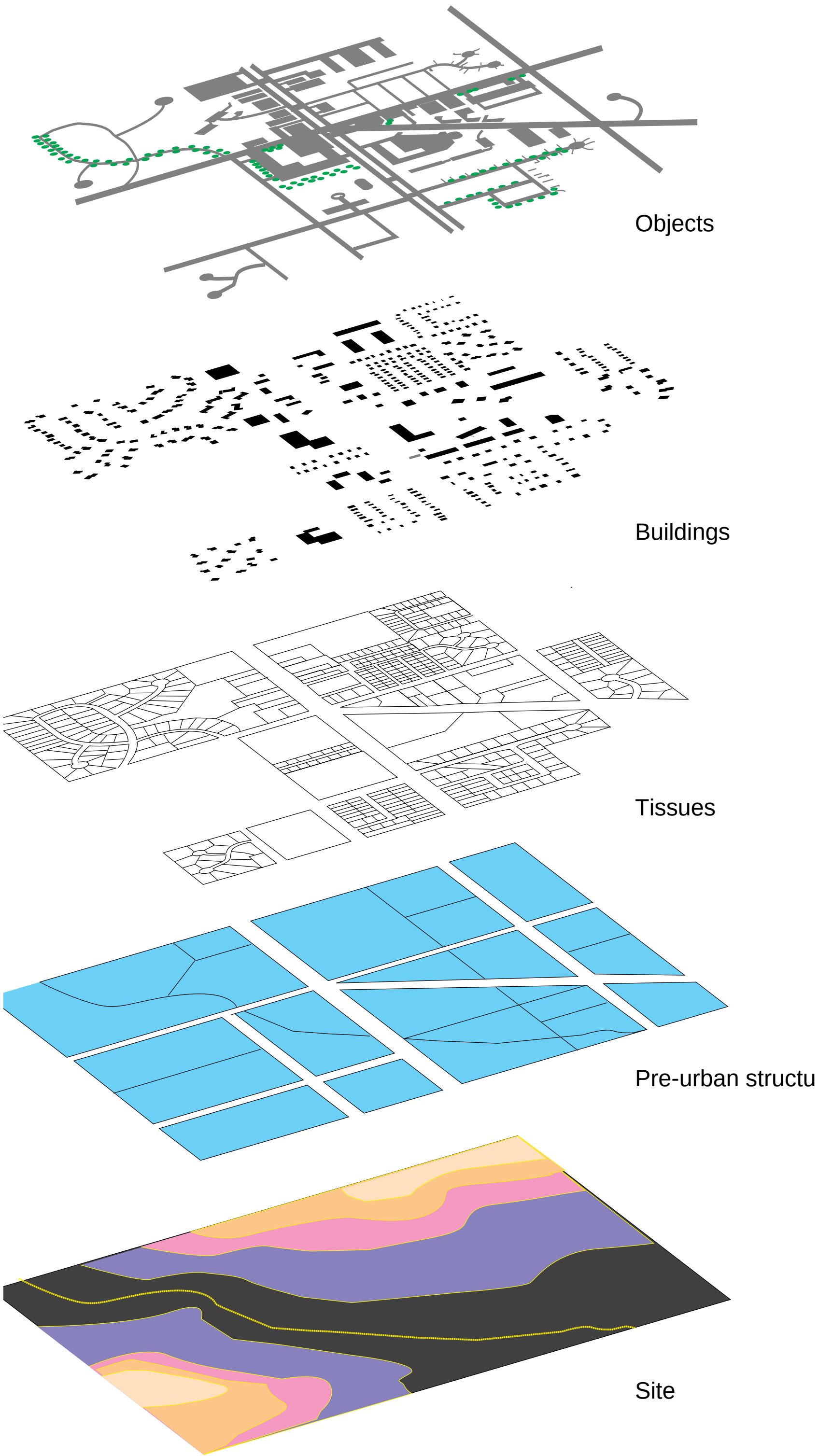
Under this system of analysis, the spatial ordering components of the city (the imaginary lines which subdivide the land) are distinguished from the actual physical components. For example, a "hedge" is a physical component which may indicate a property line for a lot (a spatial ordering component). In the same way, a paved strip and sidewalk (physical components) are distinguished from a path (a spatial ordering component) which is the land area that is set aside for a public corridor. Two broad groups of spatial ordering components (*paths* and *plots*) can be thought of as the "checkerboard" upon which the physical elements of the city are composed and built. A cadastral map makes this visible.

Although the physical object of the street paving is usually an element that requires regular replacement or even widening, the *path* of the street is the most persistent of human spatial demarcations. The path's average endurance of millennia marks it as a different temporal order than the actual physical structures of the city.

The spatial ordering component of the *plot* is also more persistent than individual buildings. Researchers have discovered that the plot is a key spatial element of the city. The plot is the demarcation of the land into discrete units of ownership or control. Although it is not a physical object, it is often represented by more ephemeral elements like fences or walls, just as the path is made obvious by its current paving. On any given plot of land, buildings may be built and adapted and destroyed and rebuilt several times, while the outlines of the plot endure unchanged.

These components --site, paths, plots, buildings, and objects – have different rates of change and they appear at different moments in the construction of a city. It is useful to divide the paths and plots into two classes, a class that occurs on a large scale and pre-dates most urban development, and a class that represents the filling out of the urbanized growth. These I call the *pre-urban structure* and the *tissues*. For any place, the site, pre-urban structure, tissues, buildings and objects are related and yet distinct.

On the next page is a representation of these components, shown as different layers of the same place. The progression of the layers represent a hierarchy of expected change from the most ponderous (site) to the most ephemeral (objects). These layers are:




1. The natural site: bodies of water and landform.

2. The pre-urban structure: paths and boundaries of pre-urban land ownership, that is, plots and paths that developed and existed before an urban settlement was developed.

3. The tissues: patterns of paths and plots that physically nestle within the pre-urban structure, and is the basic framework for the construction of all built forms.

4. The buildings: all habitable structures including permanent houses, institutions, and commercial buildings; this layer also includes the enduring and highly visible structures that inhabit the space of the paths: for example, bridges or overpasses. These structures nestle within the areas defined by the plots or paths of the tissues.

5. Objects: including cultivated vegetation (hedges, trees, and lawns), man-made objects (fences, towers, signs, monuments, wires), underground infrastructure, and surfaces: parking lots, driveways, sidewalk and street paving. These objects also nestle within the plots and paths of the tissues, but have the shortest endurance.

The collective city is a constantly changing composition of slow-changing elements constraining the everyday mom and pop changes. The static layers represent, in a tangible, physical way, the history of the city and an intense relationship with the land. More ephemeral layers, being of shorter endurance, reflect more immediate activities and ideas.  Thus it is possible to interpret the layers of the city as rich collage of interaction between the way the city was, and the way it is today.

The slower the layer is to change, the more it constrains layers that change more quickly. The permanence of the site, its resistance to even minor changes, makes the site layer an enormous constraint on the location and distribution of paths. The influence of a slower layer on a faster one is always one of *constraint.* The pre-urban structure constrains the tissues, the tissues constrain buildings, and these in turn constrain the objects. The deepest layers of the city, therefore, have a very strong affect on all other layers. Disturbances or discontinuities in these layers can be catastrophic or, at the least, very powerful. For example, changes in an established, pre-urban path will affect the rest of the layers for hundreds of years, for example, dramatically widening a small farm road, will change every tissue, building, and object that nears it.

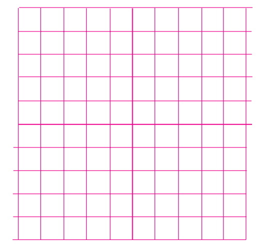
Conversely, the faster layers can only affect change in the slower layers through an aggregation of multiple changes that occur to many similar elements. The deterioration of a single building would not affect the layout of a block (the tissue layer). However, deterioration and destruction of multiple commercial buildings in an older downtown may eventually lead to the joining of small lots into larger ones (a change in the tissue). An analogy would be to the body. Normally, a few bacteria will not be able to effect a human body, even though they grow and change rapidly. A massive number of bacteria responding in the same way could, on the other hand, be devastating.

The everyday changes of the city occur at the level of objects and buildings. Objects are so easy to change that individuals do it every day: switching out a sign or putting up a fence. Buildings, too, are relatively easy to change, often under the control of one or two individuals who make unilateral decisions about adding a room, filling in a porch. Buildings and objects are routinely destroyed and replaced, often with quite different structures that are bigger, or a different type altogether. During the same time period, however, the spatial matrix of the paths and plots usually remains constant. In fact, the tissue and pre-urban layers are so resistant to change because it requires tremendous social, economic and political power to change them. Historical evidence of these changes often signal important historic events.

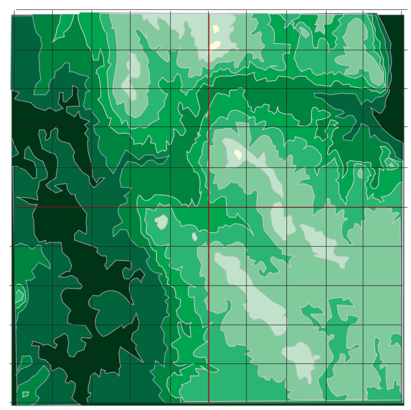
## Hudson's urban morphology

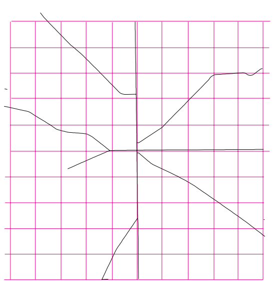
Using this model, the following analysis shows Hudson's site, pre-urban structure, and tissue patterns. Pre-urban structures and tissues have certain characteristic forms. The pre-urban structures are derived from the earliest land subdivision practices, and thus, in most US cities, are highly influenced by the gridiron of the Public Land Survey of 1785. The tissues within Hudson have been also been subdivided into tissue types, which are categorized also by their change-rates. The scope of this paper does not directly include discussion of Hudson's building layer or the object layer, but these have been studied as a part of this research.

The boundaries of the current city are the boundaries of the original township. (A “township” in the United States is a geographical unit representing, usually, 36 square miles, arranged in a square measuring 6 miles by 6 miles. ) Hudson Township was a part of the Western Reserve of Connecticut. Connecticut and most of the other original states in the US at one time claimed ownership over vast tracts in the western parts of the country. After the establishment of the federal government, the states were encouraged to cede control of these areas to the US. The “Western Reserve” was a large piece of northern Ohio that Connecticut “reserved” after it waived its other lands. Most settlers coming to the Western Reserve were Connecticut natives, which profoundly influenced the form of early towns there (Reps 1965, 229-30).

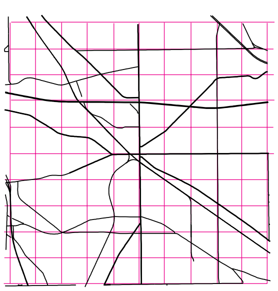


The Western Reserve was divided into townships that are five miles square (not six), encompassing 25 square miles. The owners of Hudson Township, including David Hudson, the Village’s founder, surveyed the Township into 100 equal squares measuring 1/2 mile by 1/2 mile. These are called quarter-sections, because four of them make up a square mile (a section). This survey took place in 1799 and within one or two years, the settlers of the township began to arrive. (Rogers 1973, p. 18-20)





The site topography and availability of water were not considered when the parcels of land were originally divided. It turned out that a large number of tracts in the western part of the Township were (and are) covered in swamp. The original plan called for a cross-roads “cardo” and “decumanus” typical of the Western Reserve towns, but this was not completed due to the swamps and lowlands which covered the western third of the township. The earliest roads were in place by 1839, only 20 years after the surveying of the township. By 1901, the pre-urban structure was complete, and was substantially unchanged until 1953.

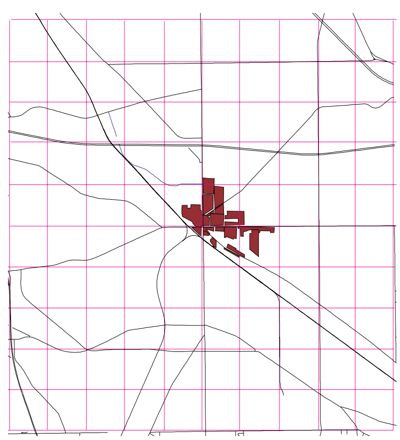


The village itself grew slowly, gained a railway, and prospered in the mid 19th century when it was the location of the Western Reserve College. When the College relocated to Cleveland, the small town declined and growth stagnated. (Rogers 1973)

Leaping forward to 1950, we find a small village on the verge of rapid expansion. One factor sets it apart from its neighbors— an intense awareness of its history and its quaint, “New England” village qualities. From the beginning of the century, in an attempt to rescue the little town from stagnation, the citizens of the Village had become obsessed with preservation, at a time when the entire preservation movement in the United States was in its infancy.  By 1950, Hudson already had acquired a reputation based on the loveliness of its village green and the variety and quality of its historic homes.

Outside the Village boundaries, in the rural parts of the township, preservation was not an issue. Beginning in the 1950's, the township grew in response to the rapid growth of much larger urban areas surrounding it and to the new ease of reaching these urban areas provided by the interstate highway system. Over the past 45 years, substantial farmland areas were converted to housing subdivisions, so that at present there is very little undeveloped land. Out of 16,000 total acres only 4,602 acres are undeveloped, which includes 762 acres of swamps, ponds, and flood plains (Plfum et. al 1996).

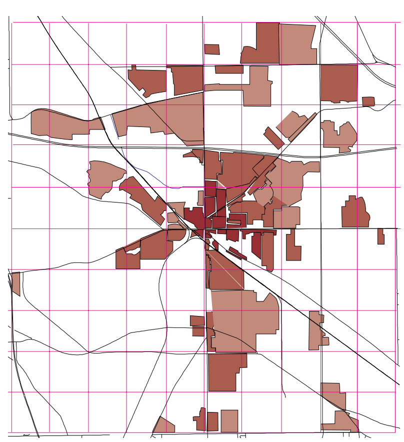
From 1970 to 1995, the township's population and land coverage grew tremendously, but the basic underlying structure (the pre-urban structure) did not change. In fact, except for the interstate highway, which has no exit within Hudson's boundaries, the road network did not change at all from 1953 to 1995, and all the roads existing in 1839 are still major roads today.  Only internal subdivision streets have been added to the street network, and more importantly, none of these new roads provide connections outside the borders of the subdivision itself.



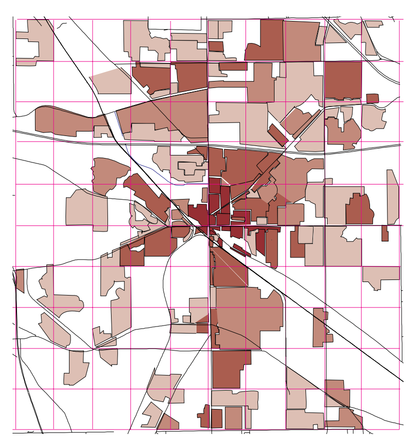
1953

1970

The subdivision boundaries preserve the spatial structure described by the original grid lines and pre-urban streets.  In fact, about 50% of the quarter section boundaries that existed in 1799 are preserved within the 1995 cadastral map as paths or as lot lines. Subdivisions, which seem



1984



1995

arbitrarily shaped and capriciously related to the street network, are actually completely derived from the pre-urban ownership patterns, mostly former wheat fields. (Subsequent analysis in non-western cities suggests that most peripheral urban form is geometrically related to the crops grown around pre-urban villages).

The conclusion is unmistakable: the overall suburban form is directly attributable to the size and shape of the pre-urban fields and roads. No amount of planning or zoning has come close to the effect that Mr. Hudson's original land survey and the subsequent subdivision of fields and pastures have been able to obtain. A simple overlay of the pre-urban structure and the site limitations is an excellent predictor of the location and distribution of tissues-areas of the built-out suburb.

Not only are the earliest fields and roads predictors of urban form, they also constrain it. Much of the suburban form that develops is strongly conditioned by these elemental pre-urban structures. When the pre-urban structure and the site are similar from place to place (and the economic drivers and legal structure do not vary) typical kinds of suburban tissues will almost automatically arise. This is one reason that so much of US suburban development is so similar. In the following section, I identify some typical tissue patterns which are evident in Hudson, but are familiar to all who study the suburbs.

**Suburban tissues**

The urban tissues which developed on or inside this pre-urban structure in Hudson developed in one of three methods, which has implications for their form and their relative endurance. The vast majority of the area was developed in planned subdivisions, where lots and streets were developed and sold for the construction of (mostly) single family homes. A second method of development is the unsubdivided development, where a tract of land is developed with several buildings, but not subdivided. Finally, especially along the pre-urban paths, the land development proceeded by a "thickening" of the settlement, passing from rural to urban almost imperceptibly as farmhouses were joined by other roadside structures.

These three settlement methods produced three distinct types of tissues which have different endurance rates and important implications for planning.

**"Static" tissues**

The most extensive development in Hudson has been in planned subdivisions. These have very distinct path/lot/building type patterns which can easily be related to the morphological idea of "tissues". Here, I introduce the notion of "static" tissues, calling attention to the relative stability of tissues with the following characteristics:

1. The lots and paths are planned together, surveyed at about the same time, and are originally built out within a short period (ten to twenty years).

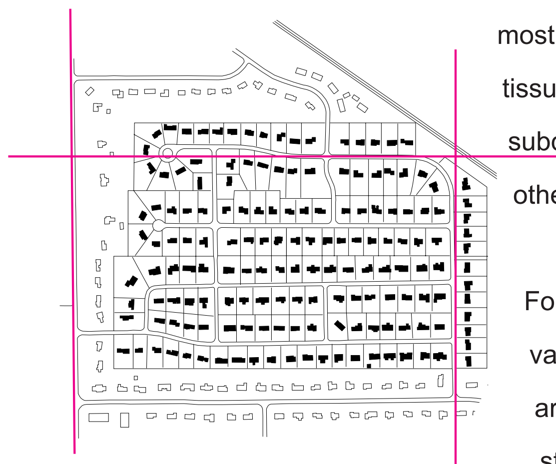
2. The lots are relatively small compared to pre-urban lots and are roughly the same size within the area of the tissue.

3. The lots usually contain a single major structure, of a type which is either consistent with the plan of the tissue, i.e., the tissue itself was originally expected to accommodate this particular type of structure, or a structure which has evolved from that type without requiring a tissue change (aggregation or further subdivision of the lots).

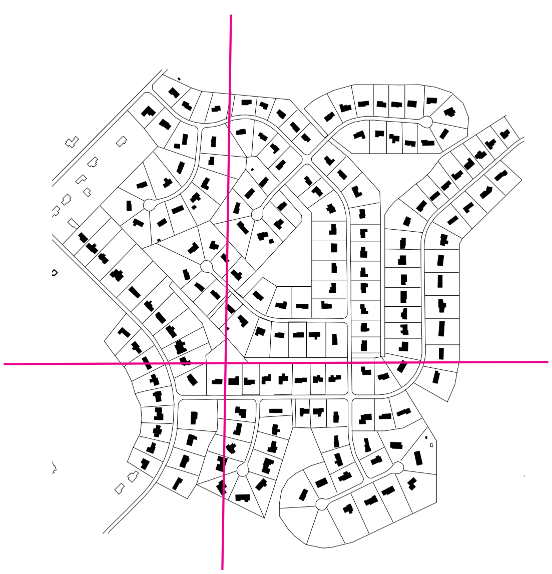
Over the development of Hudson, the static tissues have come in several different forms. These are consistent with modern subdivision types identified by Southworth and Owens (1993). The Hudson static tissues proceed in time from the original small-scale blocks of the Village, to the newer, curvilinear subdivisions of the outer township. Note that the most recent of these static tissues are not easily subdivided into “blocks” or other smaller physical units.

For the most part, the variation in path/lot arrangement of these static tissues is a stylistic variant rather than one imposed by changes in the basic typology of their intended houses. This trend reflects a growing self-absorption, where the owners of individual homes want to project an image of singularity provided by the larger lots

PRE-1953



1970



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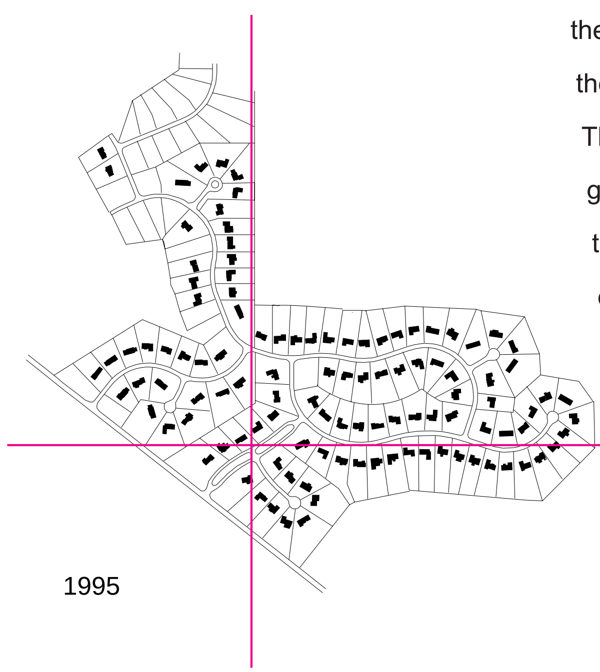


1995

and curved streets which bring the homes into separate focus as one travels down them. This contrasts with earlier tissues, where several houses visible at one time created the clear common public space of the street. Of course the variation in size of the lots is also remarkable, while the house types have changed only slightly.

The “static” label is a presumption about the expected endurance of tissues with the above characteristics. The relatively small size of the lots indicates a divided form of ownership/management that resists wholesale change by lot aggregations. Too, these forms tend to be protected through zoning regulation that prevents further subdivision. The rapid build-out of these tissues tends to favor very consistent building types. This consistency of type tends to stabilize the area: re-development that is inconsistent with the existing fabric is discouraged because it is less marketable and has a chilling effect on nearby properties.

Over a long period of time, of course, this stability is eroded by the many, many incremental changes which occur in the building structures or objects . Rooms are added, porches are removed, houses are re-sided, garages are replaced by rec rooms, lawns are paved, and eventually, the neighborhood loses its protective coating of consistency and become more vulnerable to larger changes.

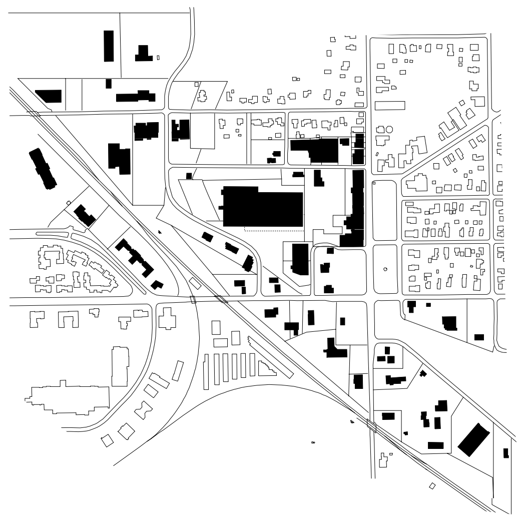
**Elastic tissues**

By contrast, the least stable of the three tissue formations is the *elastic* tissue. In Hudson, elastic tissues developed as a thickening of the rural development patterns, mostly astride the pre-urban paths. Elastic tissues have a rapid change rate compared to static tissues. Their characteristics include the following:

1. Lots tend to be large and highly varied in size.
2. Paths within the tissue are built singly rather than as logical networks. Elastic tissues often produce very few paths, instead relying on the pre-urban paths for access.
3. Lots contain a single major structure.
4. The tissue evolves over time, it is not pre-planned

Elastic tissue areas are primarily composed of retail, commercial and industrial uses, although some residential buildings are mixed in. While the continuity between traditional cities and suburban tissues is easy to see in the example of static tissues, elastic tissues defy the common definitions of “tissue” which have developed from more traditional, European examples. The difference has to do with the congruence, in the traditional examples, of building forms, lots and streets. Because these work in such systematic patterns, it is difficult to separate out the influence of various parts on the overall pattern. If the building defines the lot size and shape,

A. Roadside strip



B. Village Center

and the lots defines the block, and the blocks define the street patterns, then it is easy to assume that the building type is the primary form-giver from which all other patterns emerge. In most twentieth century American examples,  the building-lot-street relationship is much less defined. Lots are very much larger than buildings, giving substantial “play” to the possibilities on a particular lot. The lots are not necessarily arranged in geometrically defined blocks. Street patterns are whimsically related back to the dwelling type. These disjunctions occur even in extremely controlled and static suburban tissues. The disengagement of building-lot-street is even greater in the elastic tissues made up of commercial strips or industrial areas.

Most designers deplore the aesthetics of elastic tissues, but these tissues form the “breathing spaces” of a rapidly developing city. In Hudson, these areas contain the strip shopping centers, fast food emporiums and gas stations. The physical contrast with tissues is quite strong, both in the maps and perceptually.

The rate of change in elastic areas far exceed rates of change in the rest of city. Change in these areas is characterized by rapid turnover in businesses, obsolescence, major remodeling and destruction of buildings, and aggregation and subdivision of land to form new development opportunities. The tremendous pressure to develop and redevelop these areas is not inhibited by consistent fabric or small-scale ownership patterns. Even the amount of static tissue contributes to the rapid change in elastic tissue, by constraining change in vast areas of the city. In effect, the elastic tissues are the only place that significant change can happen in a short period of time.

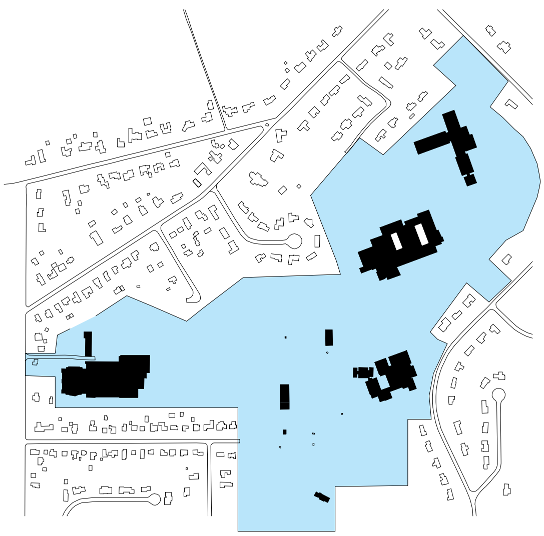
**Campus tissues**

Significant areas of the developed suburb are neither elastic or static tissue, but instead are composed of larger tracts of land owned by a single entity and developed with multiple buildings The characteristics of *campus tissues* are:

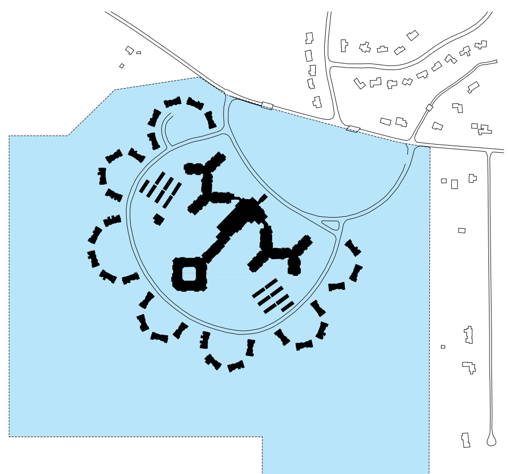
1. The lot is not subdivided, but contains more than one significant structure.
2. Internal paths act as private streets and do not form lot boundaries.

Examples of these are universities, shopping complexes, airports, apartment complexes, medical centers, corporate campuses, industrial complexes, civic centers, recreation areas and government centers.

It is difficult to generalize about the change characteristics of campus tissues. Most of the time, internal changes respond to the internal requirement of the function of the use, without the usual inhibitions of path and lots or surrounding urban structures. In this, campuses are quite flexible. There is also a marked tendency for campuses to expand into other tissues nearby, or (less commonly) to contract if the current use no longer warrants the land area. In Hudson, the most prominent tissue of this type is the campus of the Western Reserve Academy, a prep school that inherited the site and buildings of the Western Reserve College. This



A. School complex



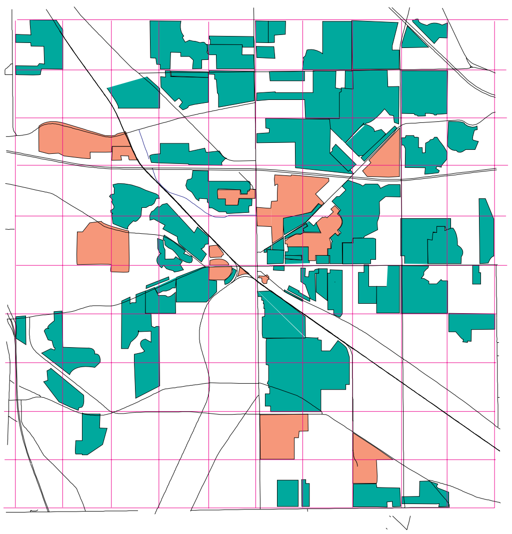
B. Apartment compex

campus had an important, established presence in the 19th century town, facing the main street. In more recent examples, campus tissues are carved from left over space between subdivisions, or established without reference to the surrounding development.

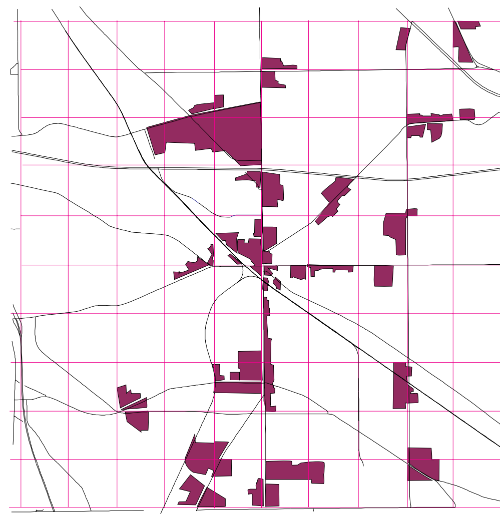
## Spatiotemporal model and the suburban tissues

The spatiotemporal model suggests that the longer the natural lifespan of a system, the more influence it has on the slower layers in the hierarchy. Using this model to understand the suburban form of Hudson, we see that the most enduring layers, the site and pre-urban structures, limit the location and expansion of the tissues, while these tissues have little or no effect on the pre-urban structure. The static tissues and campus tissues respond neatly to this model, fitting comfortably within the pre-urban structure.

In static tissues, the lots and paths form a semi-rigid matrix upon which certain changes can easily take place and others are contrained. Breaking the bounds of this matrix is an extraordinary event because it is both difficult and unusual. Too many instances of the violation of the matrix can destroy the complex harmony of the static tissue altogether, and in a sense, reformulate it as an elastic tissue or perhaps a different static one. (See examples of Over-the Rhine in Cincinnati (Scheer 1997) and Alamo Square (Moudon 1986). For campus tissues, the pre-urban structure and site is the only real constraint to change.



Static and Campi Tissues



Elastic Tissues

Changes occur slightly differently in the elastic tissues. In elastic tissues, there is no semi-rigid matrix to destroy. In most instances, building types are not particularly constrained by the lots, since the lots are not "planned" to accommodate a specific type. Instead, lots have been aggregated from smaller lots (perhaps farms or roadside houses) of no particular dimension. The lot of a strip shopping center may be far larger than the type requires, for example. More usually, a particular building is planned to maximize the use of a randomly sized lot. Another common change is to subdivide a large lot along its road frontage, leaving a larger parcel in the back with road access, and smaller lots in the front, which are developed with smaller buildings. All this leads to a tissue where the buildings are extremely varied in size, type and configuration. (Adding to this disorder is the current fad of orienting buildings at odd angles to the street.)

Elastic tissues attach themselves like barnacles to the pre-urban paths since tissue-level streets (e.g., roads in a subdivision) are difficult to coordinate among disparate owners. In a sense the elastic tissues erode the edges of the pre-urban structure. In the outlying areas of Hudson, the static tissues develop before the elastic tissues, suggesting that the elastic tissues “fill in” the leftover spaces. In current practice, developers will anticipate the growth of elastic tissues and leave gaps between the planned subdivisions and the pre-urban paths.

**Urban planning and spatiotemporal models**

Much planning for suburban areas is done in a vacuum of understanding about how these places are formed. This model of physical growth suggests that there are different planning and design interventions which are appropriate for different layers. In planning for “virgin” territory, for example it would be wise to examine the physical arrangement of existing property boundaries and rural roads, as these are likely to be the checker-board on which the real estate game is played. Once development begins, the road structure is more or less fixed despite its inadequacy. Intervention at the earliest stages of development of an American suburban region could most productively take the form of rethinking rural networks for new suburban growth.

At the other end of the spectrum, the elastic tissues pose one of the most persistent urban design problems in the modern environment: how to a bring order to areas which are inherently (and, it appears, structurally) disordered. In planning practice, regulatory and urban design techniques have been concentrated on two ends of the “control” spectrum: on the one hand, a minimum set of land use and subdivision standards allows scattered and unfocused development that is widely regarded as ugly; on the other hand, extremely strict planning controls (like new urbanism) allow almost no leeway in any development decision.

Evaluating the problem of elastic tissues in its proper place, that is, looking at the structure of lots and paths at the tissue level, affords no obvious urban design solutions short of massive restructuring. Design guidelines provide a policy appropriate to effect the building layer but do not provide not a long term solution, given the rapid change in buildings. Land use regulation might be effective if physically oriented, but this has not been effectively used for many reasons. The most common, utilitarian solution has been on the cosmetic front, where landscape and streetscape efforts (the “object layer”) reinforce the edges of the street and thus make visible one of the strongest (and most enduring) underlying forms: the street itself.

This analysis has demonstrated that the suburban form is most strongly related to patterns and shapes which do not normally come to the attention of planners. Modern regulatory process does not address some of the most important and long-lasting layers of the city, while it tends to heavily regulate and intervene in transitory conditions such as land use, building details, and built landscape. I argue that such transitory conditions should be lightly regulated to provide more leeway for growth and change, while the urban framework should be more controlled than current practice allows.

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