Pet Parcels

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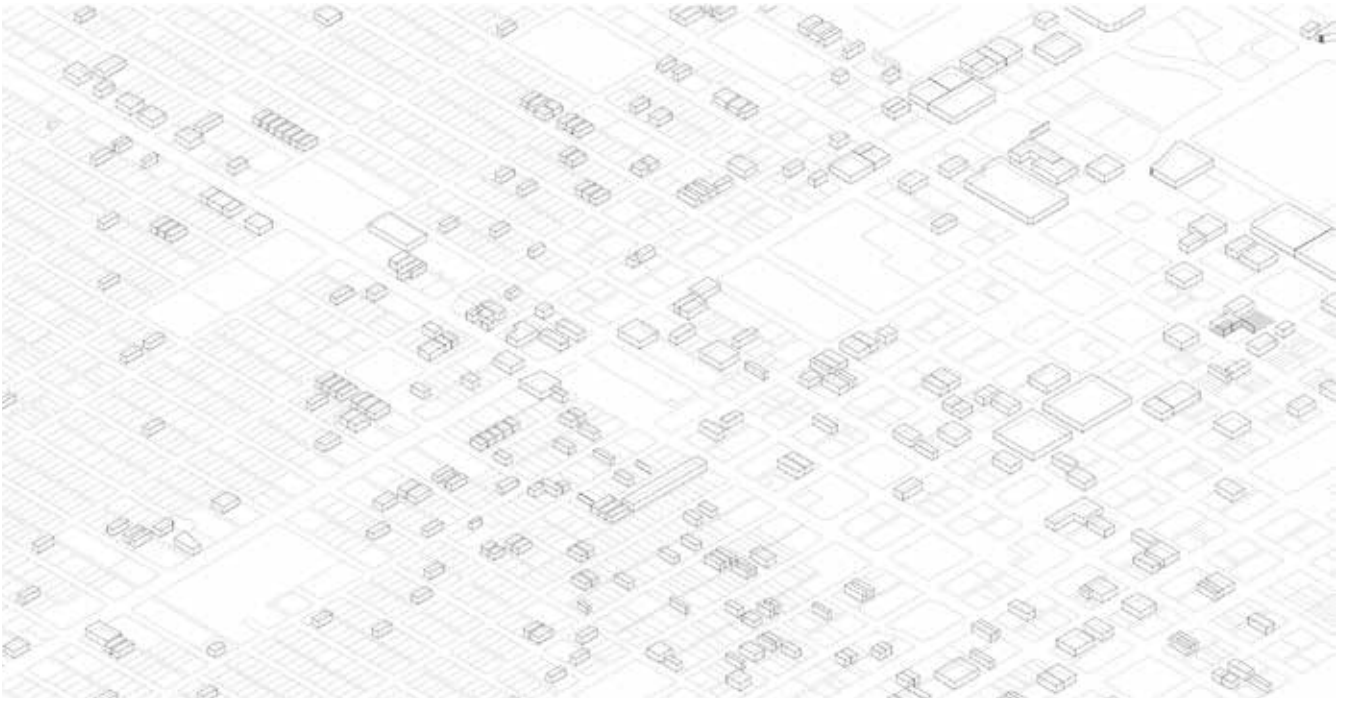

Figure 1. Isometric view of open lots in Lubbock, Texas as expressed by their buildable areas.

Keywords: digital design, urbanism, computation, representation, mapping

This study combines the concepts from Gordon Matta-Clark's "Fake Estates" with Certain Measures's cartographic RoweBot, to create a mapping tool for finding and representing open lots within cities' existing urban fabric. Referencing a lineage of urban theory by architects that spans from Colin Rowe and John Hejduk's 1957 "Lockhart, Texas" to Atelier Bow-Wow's 2001 *Pet Architecture Guide Book*, Pet Parcels proposes a historically conscious computational model for increasing cities' density. Results from an analysis of Lubbock, Texas will be shared to articulate the methodology behind this approach. With potential application by city planning agencies, community stakeholders, and architectural practitioners, this digital design method seeks to provide a tool for translating found urban conditions into parameters for generating novel design interventions.

INTRODUCTION

How can we leverage digital cartographic tools to locate leftover lots within our cities?

Combining the urban concepts embedded in Gordon Matta-Clark's "Fake Estates" with Certain Measures's techno-cartographic RoweBot, we created a mapping tool for increasing cities' density through leftover lots. Alluding to Atelier Bow-Wow's concept of Pet Architecture, we call these abandoned spaces "Pet Parcels." As residuals of cities' shifting urban morphology, Pet Parcels resist formulaic real-estate speculation and require an architectural vision beyond what most developers are capable of imagining. Utilizing GIS data with custom scripts (C#/Python/JSON), our parcel searching tool Bow-Wow-Bot analyzes locational data as well as shape metrics – both algorithmic and calculus-based differential operators – to determine the optimal Pet Parcels in a given data set.

A historical survey frames Pet Parcels within a longer lineage of urban theory by architects and artists. Beginning with Colin Rowe and John Hejduk's 1957 article "Lockhart, Texas," this paper traces over several canonical works that examine architecture's relationship with urbanism through a bottom-up approach. References to Bernard Rudofsky's *Architecture Without Architects* (1964), Aldo Rossi's The *Architecture of the City* (1966), Robert Venturi, Denise Scott Brown, and Steven Izenour's *Learning from Las Vegas* (1972), Rem Koolhaas's *Delirious New York* (1978), and Atelier Bow-Wow's *Pet Architecture Guide Book* (2001) provide a timeline for conceiving of urban form as an aggregation of incremental contributions and placing value in historically overlooked places. Where Pet Parcels diverge from its predecessors is its interest in potential opportunities over found objects. Drawing upon Matta-Clark's anarchitecture project "Reality Properties: Fake Estates" (1974), our project sees negative space as a latent medium for both revealing urban morphologies and identifying opportunities for future growth. Through an appreciation for historical precedent and context, Pet Parcels proposes an alternative model for density – one that is conducive to novel forms while at the same time sensitive to cities' existing urban fabric.

This paper documents the selection and analysis of 36 Pet Parcels across the city of Lubbock, Texas, each presenting opportunities for distinct urban interventions due to their sites' restrictive geometry and size. Lubbock was selected as a case study city for its unique context that is defined by an underlying grid and transformed over time through an array of infrastructural improvements and natural disasters. In revisiting the Texas courthouse town, Pet Parcels seeks to translate Rowe and Hejduk's early urban theories into applications for action using digital cartographic tools.

As a contextually responsive model for urban growth, Pet Parcels seeks to achieve the following: 1) increase density through leftover lots, 2) avoid displacing communities through the preservation of existing structures, 3) add value to neighboring properties, and 4) generate novel architectural forms through abandoned lots' unique geometries. Through its references to urban theory by architects and artists, this tool not only helps us to better understand the built environment through its negative spaces, but it also presents city planners, community stakeholders, and practicing architects with new opportunities for increasing density through non-standard land.

HISTORICAL CONTEXT

Pet Parcels views the relationship between architecture and urbanism from a bottom-up perspective and is indebted to the urban theories by architects who have come before. Primary amongst these is Colin Rowe and John Hejduk's article "Lockhart, Texas," that appeared in the March 1957 issue of *Architectural Record*. Written in response to an excursion in central Texas during the summer of 1955, this article exemplifies the architectural theories developed by Rowe, Hejduk, and the other Texas Rangers during their brief tenure at the University of Texas at Austin.[1] Indicative of their pedagogy that sought to connect modern architecture within a longer lineage of architectural history, "Lockhart, Texas," expresses an appreciation for historical precedent and urban context by means of drawings, photographs, and verbal descriptions of the Texas courthouse town's existing urban fabric. Through their reverence for Lockhart's "guileless architecture" and "entirely legitimate" courthouse town plan, Rowe and Hejduk's article brings attention and value to historic urban places.[2]

Since its publication in 1957, Rowe and Hejduk's Lockhart article has sparked a lineage of like-minded architectural theories on urbanism. In *Architecture without Architects*, Bernard Rudofsky's concept of "nonpedigreed architecture" not only "attempts to break down our narrow concepts of the art of building" in favor for "communal enterprise," but also champions "anonymous builders" and their "admirable talent for fitting buildings into the natural surroundings."[3] In *The Architecture of the City*, Aldo Rossi's concept of "urban artifacts," which are "characterized by their own history and thus by their own form," provides a framework for understanding cities through their constituent parts.[4] In *Learning from Las Vegas*, Robert Venturi, Denise Scott Brown, and Steven Izenour use maps, diagrams, and photographs as a method for "learning from everything" and to elevate the "ugly and ordinary" to the level of the "heroic and original" in architectural discourse.[5] In *Delirious New York*, Rem Koolhaas's reading of Manhattan as an "archipelago of 'Cities within Cities'" credits the grid – an instrument for subdividing land – for producing difference via juxtaposition.[6] And lastly in *Pet Architecture Guide Book*, Atelier Bow-Wow's term "Pet Architecture" gives a name and awareness to a "new category in urban structure" that expresses "in its size and shapes the conditions of unique locations" and manifests changes in our urban environment.[7] This lineage of urban theory by architects serves as a conceptual foundation for Pet Parcels and engrains within it a sensitivity for historical contexts and appreciation for cities' overlooked and undervalued vernacular architecture.

Where Pet Parcels contrasts with its architectural predecessors is its interest in documenting and analyzing cities' voided spaces rather than their existing built structures. In his 1974 project "Reality Properties: Fake Estates," Gordon Matta-Clark critiques the bureaucracy behind cities' ad hoc approach to demarcating land through his acquisition of fifteen residual parcels in the boroughs of Queens and Staten Island.[8] In response to the "fiscal crisis, abandonment, social tensions and depopulation" that characterized New York City in the 1960s and 1970s, "Fake Estates" proposes a methodology for citizens to preserve and transform their urban environment through abandoned and residual space.[9] Posthumously organized and arranged by his widow and executrix Jane Crawford, the project depicts through photographic collage, property deeds, site maps, and photographs fourteen of the fifteen properties (the last never being documented) to reveal gaps within the cities' urban fabric. Per art historian Pamela M. Lee, the strength of the work lies in its

"variability" that it derives from its "systems-based" approach typical of the sixties and seventies and its capacity to radiate both "backwards and forwards" in time.[10] Matta-Clark attended Cornell as an architecture student during Rowe's tenure at the program, providing a theoretical connection between Rowe's scholarship on historical urban contexts and Matta-Clark's site-specific urban interventions. It is in this spirit of historical consciousness and future growth that Pet Parcels frames left-over lots as valuable assets for densifying our cities.

Lubbock, Texas serves as a key context for developing the concepts behind Pet Parcels because of its multilayered history that echoes the conditions formative to the urban theories by Rowe, Hejduk, and Matta-Clark. As a courthouse town established in 1890 and defined by a similar grid and density, the city represents an opportunity to adapt lessons from Rowe and Hejduk's Lockhart article to a contemporary context.[11] At the same time, Lubbock's layered urban morphology punctuated by the arrival of the Santa Fe railway along the north east edge of the city in 1909, devastation caused by the 1970 tornado, and the completion of Interstate Highway 27 through downtown in 1992, creates a situation conducive to the documentation methods used by Matta-Clark in "Fake Estates."[12] This mosaic of existing structures and voided spaces provides Pet Parcels with a rich context within which to locate and analyze leftover lots, and in doing so, create a quantifiable reading of a city's history through its residual geometric forms.

METHODOLOGY

While Matta-Clark discovered his parcels by chance at auction, Pet Parcels are interested in a quantifiable methodology for finding lots irrelevant of their status in the real-estate market. We found precedent in the approach to documenting urban form taken by Certain Measures' RoweBot. In "Cartogramic Metamorphologies; or Enter the Rowebot", Andrew Witt describes RoweBots as "automated surveyors of the territory of shape and form '' that can "scan and synthesize billions of figure-ground shapes and building plans."[13] Ultimately this tool allows them to "organize formal analytics in a way that is machine readable, and thus searchable."[14] Certain Measures uses RoweBot to categorize cities into cartograms dubbed Form Maps in their Machine View series.[15] We are interested in using analytics that employs "data-science techniques to make explicit the formal associations and affinities'' to identify signature characteristics in Atelier Bow-Wow's *Pet Architecture* sites.[16] Certain Measures is creating a catalog system much like a librarian would, while we are interested in creating something much more akin to a metal detector.

In order to create a digital tool that helps us search, we first had to establish a quantifiable definition of Pet Architecture by deriving common parcel characteristics for our tool to track: novel shapes, small footprints, and contexts that are narrow and dense. Using these attributes, we developed a system for ingesting GIS Data and quantifying parcels based on their delta to our prescribed criteria. We will call our system Bow-Wow-Bot, which uses parallel processing to compute the following formal analysis: Polygon Attributes, Oriented Bounding Box, Convex Hull, Convexities, Erosion, and Medial Axis.

Three Polygon Attributes are used to quantify the parcel without computing additional polyline metrics: perimeter length, area, and point count. The sum of all polyline edges is calculated to find the total length of the polyline, a one-dimensional variable. The polyline's area is also calculated to provide an additional one-dimensional variable and constitutes one of the defining attributes of Pet Architecture parcels. Before the polyline point count is taken, the polyline is collapsed by combining segments and measured against a maximum threshold length. This helps eliminate high point counts that occur when a corner parcel has a rounded curb and should be considered a quad polygon not an n-polygon. After collapsing the polygon, the point counts are taken and tested against a Boolean condition to determine if the polyline is a quad parcel or not—another one-dimensional metric. Lastly, the polyline's perimeter area ratio is calculated by dividing the perimeter by the area, providing our first insight into the shape variance of the parcel.

Computing the Oriented Bounding Box for each parcel polyline allows us to analyze shortest edge, proportion, orientation, and area difference (Figure 2). The Oriented Bounding Box is created by taking the longest edge of a parcel polyline as the X-axis for a plane from which a regular bounding box is created and aligned to approximate a best fit condition. The bounding box's shortest edge length is measured against a maximum length of 20'—beyond which is deemed undesirable for speculative development— and the metric is recorded as a Boolean. The bounding box's shortest edge is divided by the longest edge to create a "double" which represents the proportion. This proportion tells us how far the parcel deviates from a perfect square. Using the bounding box's X-axis as a 3D Vector (which always falls within Rhino's XY world plane) we measure the angle between this and a 3D Vector 1,0,0, to give us an angle between 0 and 180 degrees. We then subtract 90 degrees from this angle and take the absolute value since we do not care if it is facing east or west as long as it is aligned horizontally on a map. This degree is then normalized to between 0 and 1 to tell us whether the orientation of the parcel is predominantly east-west, north-south, or any point in between.

We calculate the parcel polyline's Convex Hull to further quantify the shape of the parcel. By calculating the Convex Hull we are able to define additional parameters: Convex Hull perimeter ratio, Convex Hull area ratio, and Oriented Bounding Box area differential. From the Convex Hull polyline, we sum the edges to find the perimeter and also calculate the area. To compute the Convex Hull perimeter ratio we divide the Convex Hull perimeter length by the polyline perimeter length, providing a normalized metric that defines how concave the parcel is. In a similar manner, we compute the Convex Hull area ratio by dividing the

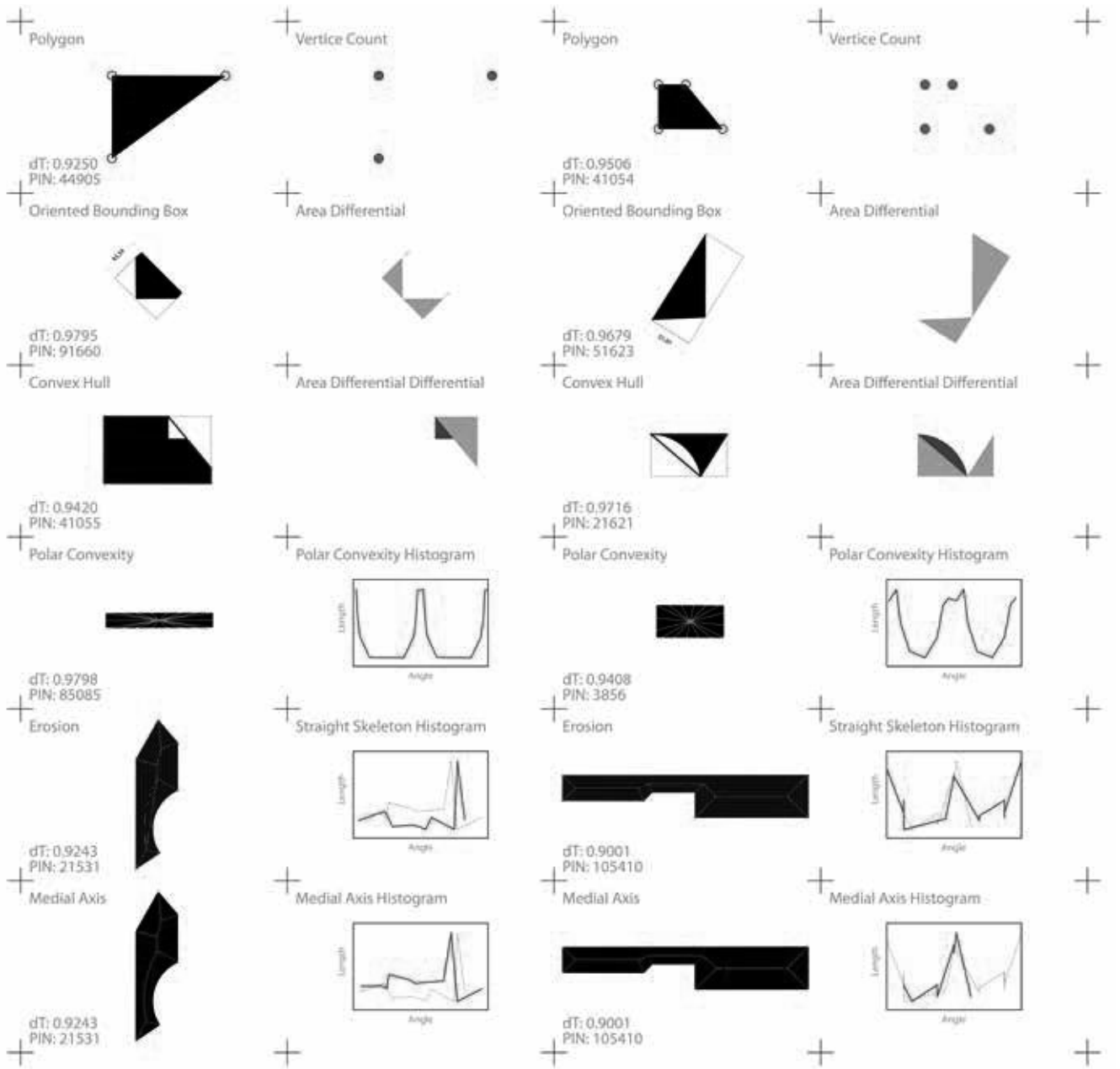

Figure 2 – First row shows vertice count. Second row shows parcels with an oriented bounding box (gray line) and the area differential (gray hatch). Shortest edge (green line) is also calculated from the oriented bounding box. Third row shows the area differential between the oriented bounding box area differential (gray hatch) and convex hull (blue line) area differential (blue hatch). Fourth row shows the Polar Convexity which is calculated by drawing lines (gray) between the polygon center and an equal distribution of points along the parcel polygon. A histogram (red) is then created with the angle and length of each line. Fifth row first and third column show the straight skeleton (red) and erosion lines (gray) and the bottom row first and third column shows the medial axis (red). The second and fourth columns show corresponding histograms (red) by taking the topological graph's segment's angles and lengths with an underlay of the opposite topological graph's histogram (dashed brown).

Convex Hull area by the polyline area and this area ratio is then used as the divisor against the Oriented Bounding Box area ratio, providing another normalized metric to further define how concave the parcel is (Figure 2).

As elaborated on in AI & Architecture, Stanislas Chailou's ArchiGAN provides precedent for the use of Polar Convexities to define a footprint by turning a "given outline into a list of discrete values (vector)".[17] The Polar Convexity is created by taking the center point of the polyline and creating vectors between it and a series of points along the polyline. A histogram is then created measuring the area and angle created by these vectors. This histogram is then converted into a vector (Figure 2).

Computing the parcel polyline's Straight Skeleton provides an additional quantified parcel shape metric. The Straight Skeleton is created through an erosion process, whereby a series of equidistant offsets is created and their vertices are used to construct the Straight Skeleton (Figure 2). Following Stanislas's method, the Straight Skeleton is then turned into a histogram of angles and lengths, which is again turned into a vector.[18] This Straight Skeleton is used to define the form features as a topology.

While the Straight Skeleton and Medial Axis are both homotopy equivalent, the Straight Skeleton identifies concave corners, whereas the Medial Axis does not and may have parabolic curves.[19] Aside from collapsing topology into quantifiable graphs, finding the histogram difference between the Straight Skeleton and Medial axis identifies a polyline's edge curvature. Similar to the Straight Skeleton, the Medial Axis is turned into a histogram by length and angle and subsequently converted into a vector (Figure 2). In addition to using the Medial Axis vector as a metric, the Straight Skeleton vector is divided against the Medial Axis vector to provide a ratio defining how curved the parcel polyline edges are.

By computing these metrics, we are able to quantitatively define the parcel type Atelier Bow-Wow identifies in their texts. With this parcel definition, we can now perform similar computations on any parcel polyline and calculate it's delta to our Atelier Bow-Wow parcel criteria, providing a tool that uses formal analysis to automatically locate geometrically anomalous parcels, which we deem as Pet Parcels.

Our first application of this method used GIS data for Lubbock, Texas. GIS data was imported into the CAD software Rhino by McNeel & Associates. This data was imported in the form of polylines with user string attributes that contain additional information. Polylines consisted of parcels, building footprints, and roads. Parcel polyline user attributes contained relevant real-estate data such as square footage, assessed land value, owner information, zoning, address, PIN, etc. Building footprint polyline user attributes contained data relating to the number of bedrooms, number of bathrooms, type, year built, height, gross building area, PIN, etc. Road polylines did not contain any user attribute data. We ran our geometry analysis computations to give the parcel polylines quantified profiles that were measured against the Pet Parcel criteria (Figure 3). The resulting deltas defined how similar a given Lubbock parcel is to a Pet Parcel (Figure 4).

In addition to this formal analysis, we also calculated urban density of each parcel by weighing lots within a dense context as more proximate to a Pet Parcels than those on the city's dispersed periphery. To calculate context density, a parcel's distance to adjacent building footprints was inversely weighed against each footprint's height and gross building area. This metric provides a quantified insight into the proximate density of each parcel.

Lubbock parcels were additionally filtered by comparing building footprint PINs to parcel PINs to select only parcels which were empty. The road polylines were used to further define Lubbock parcel polylines into front-yard, side-yard, and back-yard segments that correspond with how Lubbock County defines zoning setbacks. Using the parcel zoning information, zoning defined parcel polyline segments, and allowable envelope information, generic massing studies were generated to provide gross buildable area calculations for each site (Figure 5).

In correlation with gross buildable area calculations, the Lubbock parcels were tagged with speculative real-estate information to identify which lots present economically viable options for development. Gross buildable area price per square foot was calculated for each parcel by using a NURBS surface created from real-time pricing data that we termed the Price Surface. The Price Surface was created from a series of points where the point's X and Y variables represented the geographical location of recent sales and the Z variable represented the price per square foot of each sale. Price points were found by scrapping Zillow's database, which was done by using a browser's developer tools to inspect elements under the network's XHR, find the "userNavigation" fetch, download and parse the JSON data and represent it as points in the aforementioned Price Surface. While the Bow-Wow-Bot performs a formal analysis, this second process provides additional metrics for sorting lots that may be conducive to architectural interventions.

RESULTS

In order to test our Pet Parcel approach at a manageable scale, we selected a portion of Lubbock to conduct our analysis. The area chosen for this study was the segment of the city approximating twelve square miles bounded by Erskine Street to the north, Avenue A to the east, 34th Street to the South, and Quaker Avenue to the west. The reasoning for selecting this specific area was twofold: 1) it represents a portion of the city we anticipated to be rich in Pet Parcels due to the presence of the modern day BNSF railway, Interstate Highway 27, and the 1970 tornado, and 2) it captures both the local university to the west and the historic downtown to the east, two areas we consider to constitute the city's center. At the heart of our investigation is a desire to

identify leftover lots to densify and reenergize Lubbock's urban core, and for this reason we selected a compact area centered around the university and historic downtown.

In its analysis of this area of Lubbock, our Bow-Wow-Bot identified 1472 open lots of which 36 were selected as Pet Parcels. Per our findings we identified a total of 141,530.24 square feet of Pet Parcel land, with the average lot being a size of 3,931.40 square feet, zoned as Interstate Highway Commercial (22%), and having an assessed value of $6,523.56. In anticipating the impact of these lots on the cities' density, we applied the current building setback and height requirements to calculate a total of 184,645.67 buildable square feet, with the average Pet Parcel contributing a potential 5,129.04 square feet to the city's building stock.

In the spirit of Atelier Bow-Wow's *Pet Architecture Guide Book*, these found parcels became our waypoints for exploring the city, and in keeping with Matta-Clark's "Fake Estates" we set out to explore each parcel in person. Through photographs and Google Street View images we took a system-based approach for documenting each site's context and potential for density (Figure 5). A multimedia approach to documentation proved essential in order to capture each site's uniquely quantitative and qualitative characteristics.

We view Pet Parcels as part of a larger investigation to identify underutilized lots as potential sites for increasing cities' density through novel architectural interventions. As an initial exercise, Pet Parcels provides a set of tools and methodology for quantitatively finding unique parcels through their geometry and size. In revisiting our initial goals for the project, Pet Parcels addresses our aim to increase density through leftover lots which avoids displacement and fosteres the preservation of existing structures. Where the research can be developed further is by addressing our goals for assessing the impact of Pet Parcels on their neighboring communities. Measuring how Pet Parcels affect the economics, ecology, and demographics of neighboring properties, and what type of architectural forms might arise from the combination of their restrictive geometries and permitted uses by local zoning are two areas for future development. This study does not represent a final solution for identifying and engaging with leftover lots, but through its selection and curation of these 36 Pet Parcels it presents an initial vision for bridging the relationship between architecture and urban design through historically sensitive digital tools.

DISCUSSION: SHORT TERM AND LONG TERM NEXT STEPS

Short term next steps for this project are two-fold, first applying this methodology to other cities and second using a similar computational methodology to generate Pet Architecture on leftover lots. By studying the morphology of other urban areas and teaching our tool to develop primitive massings responsive to context and program, Bow-Wow-Bot can increase its value and applicability through its capacity to respond to a wider range of conditions and translate mapped findings into designed architectural proposals.

By applying Bow-Wow-Bot to a greater number of cities we hope to identify blind-spots in our current mapping system and create a catalog for making urban comparisons. Lubbock is an excellent context for developing our script and code due to its systematic grid and flat topography. By applying Bow-Wow-Bot's principles to additional cities we hope to use their variable contexts to build upon our tool's capabilities and increase its analytical capacity to accommodate new attributes such as changes in topography and non-gridded urban layouts.

In teaching Bow-Wow-Bot to create primitive massings we aim to translate found existing conditions into a system for developing conceptual designs. Due to their prevalence and compact size, Pet Parcels provide a rich data set for developing a methodology for generating architectural form that synthesizes parcel geometry with architectural considerations such as ingress, egress, and parking. Through their small-scale, Pet Parcels have the potential to develop an intelligent bottom-up approach to generative design that embraces existing urban fabric and formal difference over tabula rasa conditions and genericism.

As a long term project, we envision Pet Parcels having a greater impact beyond their geometric boundaries and identify three key constituents as potential beneficiaries from our study: city planning agencies, community stakeholders, and architectural designers. By working with these prospective partners, our Bow-Wow-Bot can be refined to better address local issues and inform decisions to densify cities through a contextually sensitive quantitative approach.

For city planners, Pet Parcels can contribute in the following ways: 1) identify developable lots that have the potential to grow cities' tax base, 2) increase the density of urban cores while retaining existing building stock, and 3) provide a platform for testing and visualizing the impact of zoning ordinances and form based codes on atypical lot conditions. Whereas city agencies have historically approached issues of density from the top down—as evident by the urban renewal projects of the 1950s and 1960s—Pet Parcels provide an opportunity to approach density from a more holistic, bottom-up perspective that takes into account the value, both economically and culturally, of cities' historic spaces and existing structures.

For community stakeholders, Pet Parcels can contribute by: 1) creating an entrypoint for first-time developers, 2) providing opportunities for local stewardship of city land through community land trusts (CLT) and similar non-profit community-based organizations, and 3) raising the value of adjacent properties through controlled, incremental growth.[20] While large-scale development by outside interests threatens to gentrify and displace existing community residents and businesses, Pet

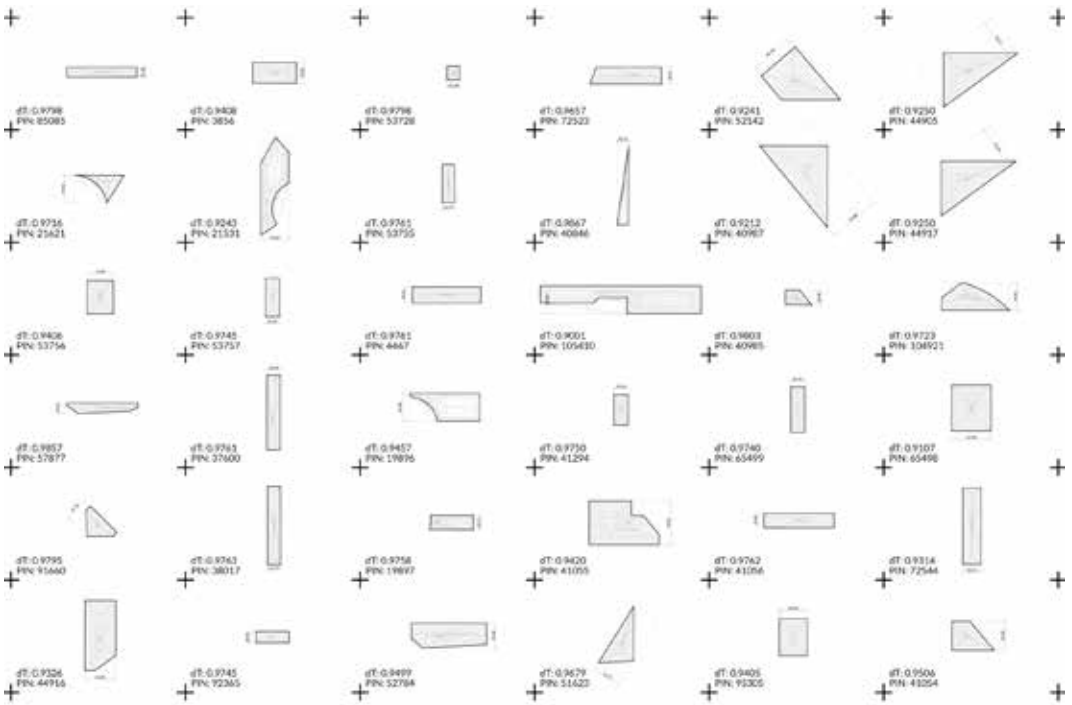

Figure 3 – Lubbock Texas Pet Parcel analysis geometry overlays for 36 selected parcels.

Figure 4 – Pet Parcel analysis applied to Lubbock, Texas with results shown in an RGB spectrum to differentiate based on size (red), novel shape (green) and context density (blue).

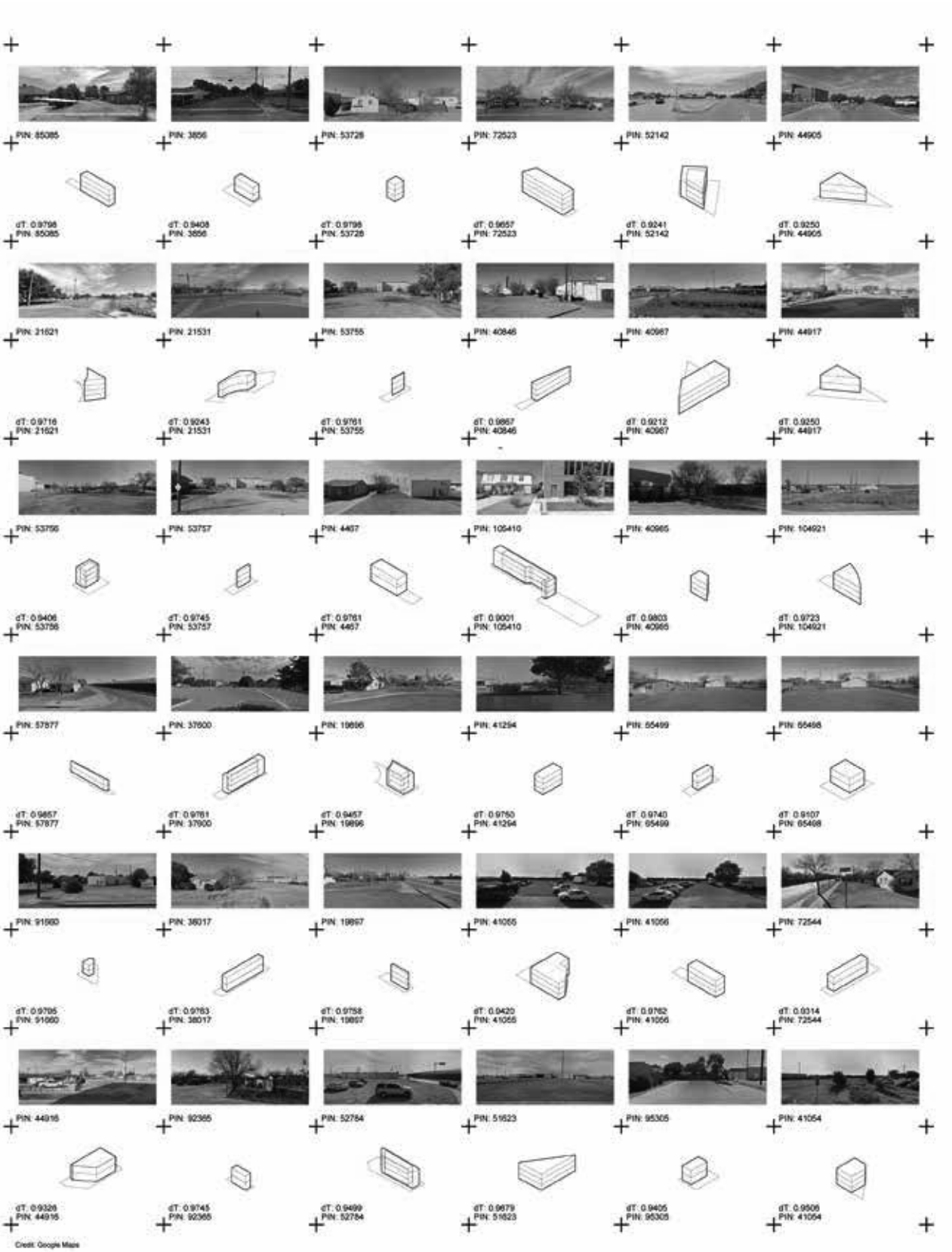

Figure 5 – Local zoning ordinances were used to generate massing to understand the buildable area for each Pet Parcel site. Massings of buildable area generated from local zoning ordinances and street view images of all 36 Pet Parcels. (Credit: Google Maps and photography by authors)

Parcels provides a framework for local stakeholders to gain a controlling interest in their local community's future growth and wealth distribution.

Lastly for architects, Pet Parcels can contribute by: 1) identifying unique urban opportunities for realizing novel architectural forms, and 2) increasing participation and design input at the development stages of built projects. Due to their atypical geometry and small size, Pet Parcels are inherently difficult to develop and require a high degree of spatial ingenuity and imagination in order to attain value in the eyes of developers and investors. Architects by their training are uniquely positioned to address and leverage the constricting limitations of these sites, and in doing so, have the opportunity to design novel forms and juxtapose varying uses in creative ways—much in line with the way Atelier Bow-Wow identifies Pet Architecture within the fabric of Tokyo. Furthermore, the necessity of a strong schematic design to justify the development of these atypical lots creates an opportunity for architects to become involved earlier in the development process and thereby acquire greater agency and say in the way buildings are conceived and constructed in our urban environments.

It is through these partnerships where this study sees its long term plan for development. By leveraging its tools to build, Pet Parcels can begin to translate the historically conscious theories by Rowe, Hejduk, Matta-Clark, and Atelier Bow-Wow into meaningful action for urban densification.

CONCLUSION

Drawing upon a lineage of architects who frame the relationship between architecture and urbanism from the bottom-up, Pet Parcels proposes a historically conscious and contextually sensitive methodology for locating leftover lots within cities' existing urban fabric. In reference to Gordon Matta-Clark's anarchitecture project "Fake Estates," this study focuses on the negative spaces within our cities, valuing them for their ability to synthesize historical contexts with a call for action. Beginning with Atelier Bow-Wow's Pet Architecture as an end goal, Pet Parcels work backward in time, deconstructing existing boundaries in order to reveal geometric conditions conducive to small scale interventions.

Beyond their geometric borders, Pet Parcels hold the potential to benefit city agencies, community stakeholders, and architectural designers. In partnering with constituents with a confluence of vested interests in their cities, digital tools such as Bow-Wow-Bot have the opportunity to extend their utility beyond the act of mapping and initiate action through the process of design. By starting with the small and the overlooked, Pet Parcels revisits the lessons learned from Rowe and Hejduk's summertime trip to Lockhart and finds value in cities' existing urban fabric to guide our future growth.

DATA STATEMENT

Data available on request from the authors.

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