Thinking Outside the Blocks – Exploring Alternatives to Traditional Neighborhood Design

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Abstract

Evaluating neighborhood design concepts with respect to economics, safety, and travel efficiency is critical when determining the livability of an area. This paper aims to illustrate the analytical and visualization benefits of GIS for developing, analyzing, and visualizing neighborhood design and planning concepts by comparing alternative hexagonal designs to traditional curvilinear, loop and cul-de-sac designs. The adaptations maintain parcel count, existing natural and development boundaries, and conform to modern subdivision regulations. The results exemplify increases in safety and travel efficiency, demonstrate reductions in development costs, and encourage the use of hexagonal planning as a valid alternative to traditional design considerations. The discussion will explain the project's design, the geoprocessing and visualization methods used, and the implications of the results on the planning process.

Trend is not destiny.

- Lewis Mumford

1. The Need to Revisit Hexagonal Design and Planning

Lewis Mumford's timeless words could not better describe the necessity to reconsider the foundation of an enduring aspect of American life, the design of our suburbs. The field of urban planning has benefited from the wealth of knowledge derived from its interdisciplinary nature. Planners, as a collective of architects, geographers, sociologists, environmentalists and others who are concerned with urban design and function, have long regarded the establishment of a rigid grid pattern for residential neighborhoods as a practice to avoid. There was shared belief that it is "not only ugly, dangerous and unhealthful, but it is inefficient and expensive" (Cauchon 1929, 42). During the first three decades of the 20th century, numerous design alternatives were proposed to counter the ills of the rectangular grid system. From the variations arose two promising concepts. One method involved the use of a hexagonal street network, and the other utilized curvilinear roads, loops, and cul-de-sacs. Both had their merits with respect to economic, health, and visual appeal. However, only one option was substantially promoted to become the eventual successor to the grid plan. As a result of the opinions of influential planners and government proceedings established to mitigate the effects of the Depression, the curvilinear, loop and cul-de-sac design was deemed most viable. The subsequent design standards developed during the 1930s ensured the unconditional adoption of that preferred design style and continue to serve as the basis for subdivision development today.

The dismissal of hexagonal design from planning consciousness is apparent in current neighborhood structure. The systemic obliviousness of hexagonal design alternatives to American suburban development propagates the continued belief that curvilinear, cul-de-sac infused neighborhoods is the best practice. Current ideology should be reevaluated with the possibility that a more desirable concept exists. Desirability over the curvilinear, cul-de-sac design can be demonstrated by a practical hexagonal alternative that can lower construction costs by reducing infrastructure, improve travel efficiency by adapting flexible intersection controls, and promote safety by reducing the number of vehicular conflict points while allowing for the possibility of reduced travel speeds without additional travel time over standard subdivision designs, while also conforming to modern subdivision guidelines established to regulate residential development.

The natural properties of hexagons dictate that when they are tiled, they will provide the greatest area with the smallest perimeter compared to any other pattern. It has been proven that “any partition of the plane into regions of equal area has the perimeter at least that of the regular hexagonal honeycomb tiling” (Hales 2001, 1). This can be translated into the language of a planner or developer to indicate that the length of road for a given area will be less in a hexagonal network than with any other shape, including the square. Water, sewer, and other utility installations closely follow street layout. Roadways provide “the most convenient and economical location to place gas mains, sewers, and water-supply pipes” (Adams 1934, 158), and it reasons that as road length changes, so does the need and costs for corresponding infrastructure.

The primary objective of this research is to revisit the concept of hexagonal design, which has been ignored as a subdivision design alternative in America for the past 70 years, and to evaluate its merits over current development practices using modern geospatial technology. The appraisal is accomplished by translating two existing residential subdivisions with varying natural and developed characteristics within the City of College Station, Texas. This transformative aspect of subdivision design is unique in its attempt to adapt an existing subdivision into one of a hexagonal design while maintaining parcel count, established boundaries, and existing natural features. The hexagonal variations presented in this research aim to connect the traditional and novel aspects of subdivision design. The design progressions deviate from conventional neighborhood design while maintaining semblances of it. Incorporating hexagonal structure with this foundation demonstrates the potential for evolutionary succession in design thought that is both familiar and innovative.

This research is integral for reintroducing an alternative design model with which to build a more economically feasible and favorable living environment. The goal of this research is to identify the adaptability and infrastructure, safety, and travel benefits of a hexagonal neighborhood plan compared to its curvilinear counterpart as a persuasive approach towards the adoption of a honeycomb pattern as a practical, realistic, and readily useable design consideration.

2. Research Design and Methods

Two subdivisions, Shenandoah and Springbrook, of the City of College Station, Texas were the focus for the hexagonal transformation. The current subdivision boundaries, land use, parcel

count, and proper adherence to the College Station Comprehensive Plan and Unified Development Ordinance codes and standards were obeyed.

Home to nearly 1,600 residents, Shenandoah is predominately comprised of single-family residences and is indistinguishable to countless other suburbs in the city and throughout the country. A public recreation facility and a park are both located within the subdivision's boundaries as well. Though the housing is typical of suburbia, the inclusion of open spaces, and the preservation of them, made Shenandoah a candidate for translation. Shenandoah's design is based upon a basic grid pattern. Though it isn't a strict a checkerboard design per se, it primarily consists of straight and perpendicularly intersecting roadways.

The Springbrook subdivision is home to nearly 500 College Station residents. Like many subdivisions in the city, it is comprised of single-family residential parcels, and each street offers little, if any, variety from neighboring ones. One aspect of the subdivision that differentiates it from many others is the large swath of designated greenway stretching diagonally throughout the neighborhood that contains a branch of floodplain. Springbrook's layout embodies the curvilinear, loop and cul-de-sac arrangement propagated from the FHA's design standards. A successful translation of the two helps emphasize the flexibility and adaptability of hexagonal design to accommodate a variety of physical and natural characteristics.

Geographic Information System (GIS) technology was used to analyze the actual and translated subdivisions' attributes. Zoning designation, parcel count, parcel size, park size, greenway

boundary, subdivision boundaries, road length, right-of-way area, speed limits, traffic control signage, and intersection count are measures considered in the analysis.

Information regarding land-use, parcel information, and subdivision boundaries was obtained through the Brazos County Appraisal District. Street, flood plain, water and sewer information was obtained through the College Station's GIS Department. Infrastructure cost analysis is based upon the engineering cost estimates provided to the City's Department of Public Works by the developers.

2.1. Infrastructure

Determining the length of roadways needed to service a standard neighborhood and the change in length in its hexagonal counterpart is necessary to understand the difference in development costs associated with the competing designs. Development expenditures are based upon engineer cost estimates provided to the City which include itemized pricing for Streets/Sidewalks, Storm Sewer, Sanitary Sewer, Manholes, Water, and Fire Hydrants (DPW 2002). They are used by the City to adjust their inventory valuation assessment of additional infrastructure within their jurisdiction.

GIS, along with the engineering costs estimates, was used to compute the cost of infrastructure per linear foot of roadway. The total engineering cost estimates of the four latest phases of Shenandoah were divided by the length of roadways created to serve them to produce a dollar value per linear foot of infrastructure. An excerpt from Phase 9 of Shenandoah is shown in Figure 1. The cost per foot was then multiplied by the total length of road network in each

subdivision to establish an overall cost for the subdivision. The cost estimates reflect 2002-2003 US dollar values, as that was when the cost estimates were submitted. The length of infrastructure per parcel is calculated by dividing a design's total street length by the number of parcels it contains. This number, multiplied by the cost per linear foot of infrastructure, provides the development cost per parcel.

By the attached letter of completion for Shenandoah Phase 9, we have accepted the following improvements for the City of College Station infrastructure.

INFRASTRUCTURE	QUANTITY	VALUE
STREETS/SIDEWALK		$294,326.80
STORM SEWER		$133,122.00
SANITARY SEWER		$ 89,530.00
MANHOLES	11	$ 13,400.00
WATER		$109,817.00
Subtotal:		$640,195.80

Figure 1 – Excerpt from Shenandoah Phase 9 engineering cost estimate.

2.2. Travel Efficiency

Travel efficiency is another aspect of hexagonal design included in the comparison. The speed with which residents are able to travel through a neighborhood has safety implications since greater travel efficiency could improve neighborhood safety by translating into lower overall travel speeds while maintaining the same travel time when compared to the original version (Litman 1999). Neighborhood travel speed is dictated by speed limits and intersection controls. Of the two, the placement and selection of control signs has more of an impact at the local level. Certain signage produces longer travel delays than others. This is apparent when comparing

average delays from Stop and Yield controlled intersections. Excessive controls, such as an overuse of Stop signs, can cause more harm than they prevent, as drivers mitigate the slowing effect of Stop signs by speeding between intersections to recoup the delay (Noyes 1994, 43). The use of Yield signs at three-way intersections, when warranted, should promote a steady stream of movement instead of pulses from intersection to intersection, resulting in traffic flow that is less erratic. Yield signs "can be used effectively to control traffic at minor intersections in urban areas, and a low accident frequency can be expected" (ITE 1978, 42).

Yield signs have been shown to have advantageous properties over their Stop sign counterparts. An FHWA sponsored report indicates that the type of signage greatly impacts travel time, "with STOP control producing the longest travel time and YIELD control the shortest" (McGee and Blankenship 1989, 20). In addition, a University of Maryland study in 1986 concluded, "YIELD control provided a more efficient intersection operation than STOP control in terms of overall shorter delay to motorists" (McGee and Blankenship 1989, 21). The expected average delay per vehicle for Yield-controlled intersections was found to be 3.6 seconds, whereas the average delay was found to be more than double, at 7.9 seconds for Stop-controlled intersections (Leisch, Pfefer and Moran 1967, 36-38).

The difference in travel delay between Shenandoah, Springbrook, and their hexagonal counterparts is calculated by assigning the specified delay of 3.6 or 7.9 seconds depending on sign control, to the time needed to travel the length of the street segment. The delay is used to adjust the average travel speed per street, as shown in Table 1. The sample calculations are based upon an arbitrary road 440 feet long, with a 30 mph (44 ft/s) speed limit.

	Travel Time (sec.)	Speed (mph)
No Delay	10	30.0
Yield Delay	13.6	22.1
Stop Delay	17.9	16.8

Table 1 - Adjusted Speed (mph) for No, Stop, and Yield intersection controls.

A conservative estimate for average speed for each neighborhood is calculated based upon the existing and adjusted values for each street within a neighborhood. The nature of Yield signs allows for no delay at intersections in the absence of oncoming traffic. The calculations assume that a full stop is made at each Stop sign and that each Yield requires delay. The travel efficiency comparison between neighborhood designs is based upon average travel speed for the entire design.

As a result of the safety and travel benefits offered by three-legged intersections and Yield signs, the hexagonal translations will utilize three-legged Y and T-intersections and appropriate Yield and Stop sign controls where warranted. The placement of Yield signs in the hexagonal translation is done in a way to facilitate vehicular movement and promote travel safety by their guidance.

2.3. Safety

Safety is another aspect of hexagonal design included in the investigation that is closely linked to both travel efficiency and road network design. There are three common intersection varieties encountered in curvilinear and hexagonal designs. They are the standard four-way intersection, T-intersection, and Y-intersection. In each case, the roads involved are two-lane and travel occurs in both directions. A four-way intersection is the junction where two streets cross

orthogonally. The design of a T-intersection is such that one road intersects another perpendicularly without continuing through. A Y-intersection is comprised of three roadways, whereby each one emanates from the intersection point at a 120˚ angle from the other two.

Inherent safety benefits can be attained by hexagonal design due to the presence of three-legged intersections. Their enhanced safety is derived by a reduction in the frequency of conflict points which lower the opportunity for collisions, as well as in increased viewing angle of oncoming traffic over perpendicularly or acutely angled intersections, mitigating the operational concerns presented by acutely skewed intersections (Gattis and Low 1998). For the purpose of this research, level of safety is quantified by the extent that conflict points are present. The number of conflict points of a four-way intersection (32) greatly exceeds those of T and Y intersections (nine each), as shown in Figure 2. In respect to serious collisions, four-way intersections "were found to experience four times the frequency of T- and Y-types" (McGee and Blankenship 1989, 20), in one study and "T intersections were found to be fourteen times safer than four-leg intersections" (Southworth and Ben-Joseph 1997, 92), in another. The conflict points of a Y-intersection become apparent when, for example, three vehicles approach a Y-intersection simultaneously, each with the intention of turning left. This problem can be alleviated by a sign control on one leg, and standard driving etiquette on the others by allowing the driver on the right-hand leg of the unsigned intersection to proceed first.

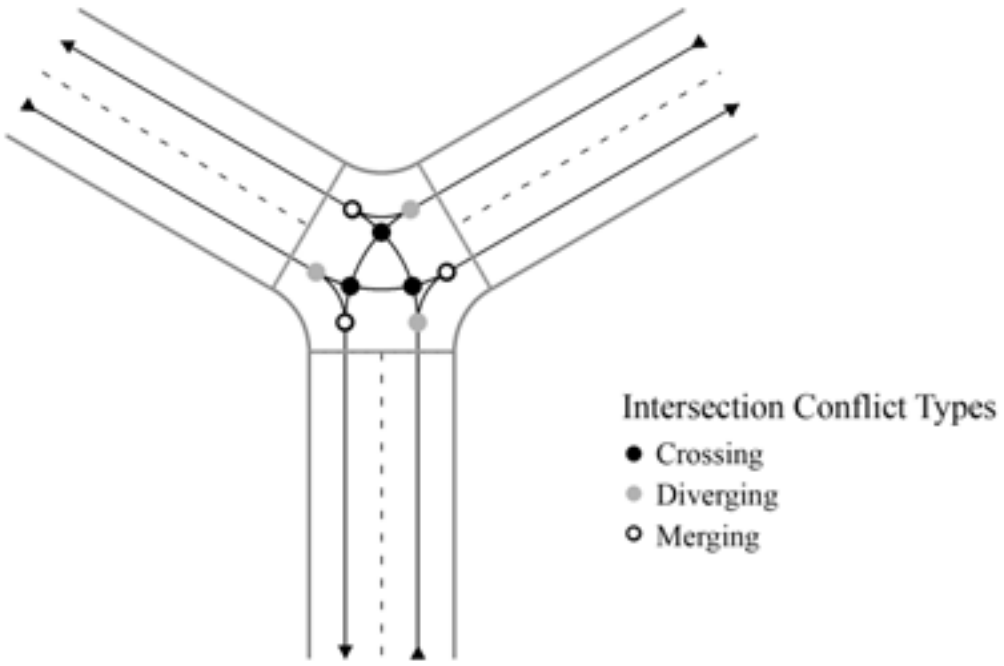

Figure 2 - Y-intersection conflict point types.

Analyzing the number of intersections, types, and total number of conflict points for each design consideration will allow for a meaningful safety comparison.

Hexagonal designs encourage improved safety by allowing for the possibility of reduced travel speed without diminishing travel time as compared to a standard design due to increased travel efficiency in conjunction with a reduction in intersection conflict points.

3. Analysis and Findings

The results are divided into two sections, one relates to Shenandoah and represents an iteration of subdivision design which resembles characteristics of the traditional grid, and the other relates to Springbrook which embodies the practice of curvilinear, loop, and cul-de-sac design. Each

section will contain components that illustrate the land use, infrastructure, safety, and travel comparison between the real-world subdivision and its hexagonal counterpart.

The land-use sections compare Residential, Non-Residential, and Right-of-way area between design types. Residential area reflects the coverage of single-family residential parcels in the subdivision. These are platted as such in the real-world versions. In Shenandoah, Non-Residential area accounts for commercial development on the outskirts, a public recreational facility, and other common areas not used for residential habitation. Shenandoah's park space corresponds to the city park within the subdivision boundary. In the hexagonal translation Non-Residential also includes 'extra' space produced by the geometric arrangement. The right-of-way value is based upon the area that is neither Residential, Non-Residential, nor Park, as right-of-way is all that remains. In Springbrook, the Non-Residential designation accounts for undeveloped area that corresponds with the location of the greenway, as well as other open space produced in the redesign.

3.1. The Shenandoah Translation

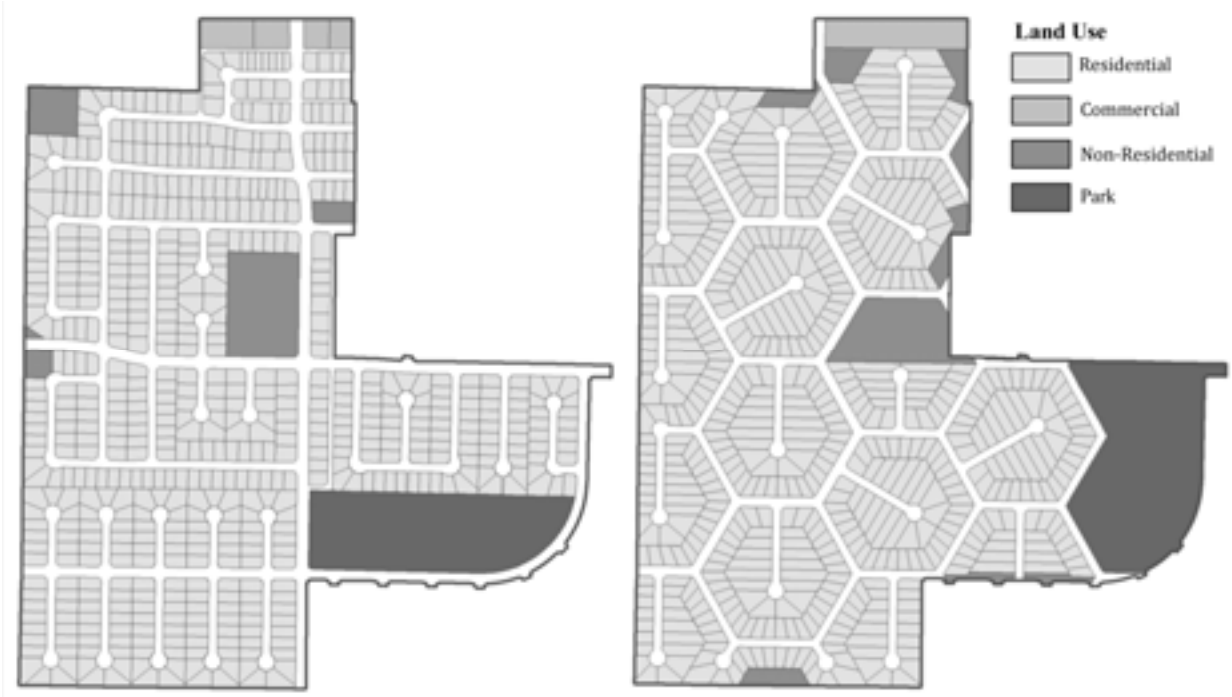

Figure 3 - Original and Hexagonal versions of Shenandoah.

3.1.1. Land-Use Comparison

Shenandoah and its hexagonal translation are illustrated in Figure 3.

	Shenandoah	Hexagonal Shenandoah
# of Parcels	599	599
Minimum Parcel Size (ft²)	4,328	5,403
Mean Parcel Size (ft²)	8,680	9,254
Median Parcel Size (ft²)	8,450	7,386
Maximum Parcel Size (ft²)	19,454	20,738

Table 2 – Parcel comparison between Shenandoah designs.

	Shenandoah	Hexagonal Shenandoah
Residential	5,199,239	5,543,420
Non-Residential	527,713	620,575
Park	629,989	771,712
ROW	1,950,049	1,371,283
Total	8,306,990	8,306,990

Table 3 - Area (ft²) distribution comparison between Shenandoah designs.

Tables 2 and 3 illustrate the land use characteristics of Shenandoah and its hexagonal complement. Table 2 presents the differences in parcel size between the versions. Table 3 demonstrates the distribution of land-use area for each subdivision style. Shenandoah exhibits an increase in average parcel size when translated into a hexagonal design. The original Shenandoah parcel size minimum, mean, and maximum all increase. The initial average parcel size of 8,680 ft^2 rises to 9,254 ft^2, an average increase of 574 ft^2 per lot. Hexagonal Shenandoah utilizes 344,181 ft^2 more space for residential parcels, 92,862 ft^2 more for non-residential parcels, 141,723 ft^2 more space for the park, and 578,766 ft^2 less for the right-of-way. The median parcel size decreases from 8,450 ft^2 to 7,386 ft^2.

3.1.2. Infrastructure Comparison

	Shenandoah	**Hexagonal Shenandoah**
Length of Roads (ft)	35,702	25,084
Length of Road per Parcel (ft)	59.6	41.9

Table 4 - Infrastructure comparison between Shenandoah designs.

	Shenandoah	**Hexagonal Shenandoah**
Development Cost ($/ft of road)	176	176
Development Cost per Parcel ($)	10,490	7,374
Total Development Cost ($)	6,283,552	4,414,784

Table 5 - Development cost comparison between Shenandoah designs.

The results indicate decreases in the amount of infrastructure, as shown in Table 4 and Table 5. Shenandoah contains 35,702 linear feet of roadways and accompanying infrastructure, whereas its hexagonal counterpart utilizes just 25,084 linear feet. The result is a decrease of 10,618 ft, which is equivalent to 2.0 miles or 29.7%. The cost per parcel decreases from $10,490 to $7,374,

a reduction of $3,147. This translates from an original subdivision development cost of $6,283,552 to a cost of $4,414,784, a savings of $1,868,768 or nearly two million dollars.

3.1.3 Travel Efficiency Comparison

Figure 4 illustrates the placement of Stop-controlled intersections within the original Shenandoah design and the location of Stop and Yield controlled intersections within the hexagonal alternative.

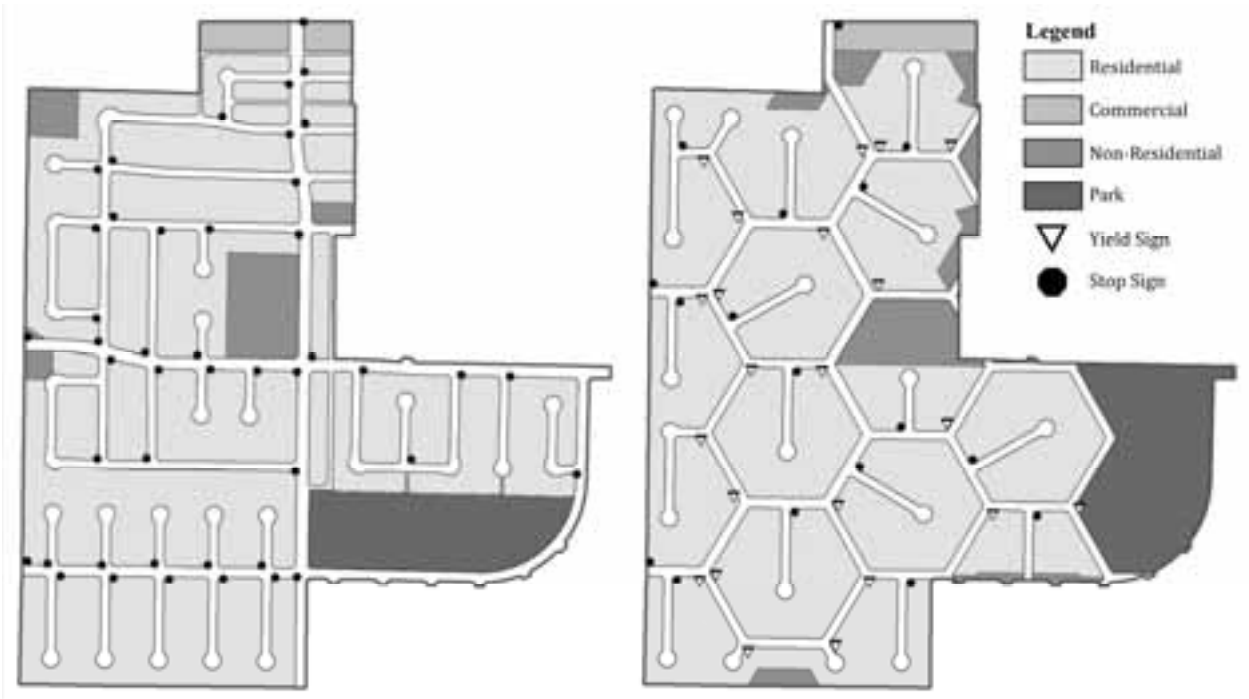

Figure 4 – Stop and Yield-controlled intersections for each version of Shenandoah.

The location of intersection controls determined by roadway geometry and by functional classification. The original and translated roadway systems are shown in Figure 5.

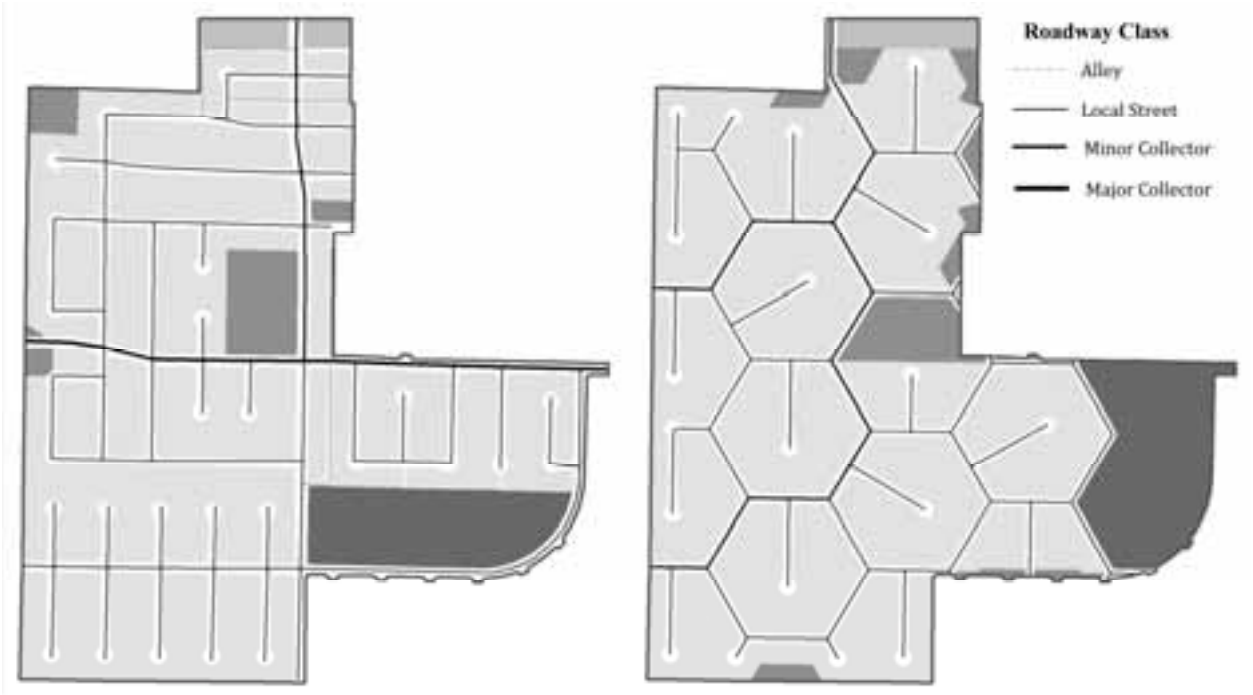

Figure 5 - Roadway Classification for each Shenandoah version.

The optimal, unimpeded average speed in Shenandoah is 30 miles per hour accounting for differences in speed limits for the functional roadway classes. The average is reduced to 22.2 mph when Stop-controlled intersection delay is factored into travel speed. Mixed intersection controls are implemented in the hexagonal version and represent an overall average speed of 23.6 mph. The alternative design and intersection controls yield a 1.4 mph average speed increase, as shown in Table 6. Navigating Shenandoah's 35,702 feet of roadways at an average of 23.2 mph produces an overall drive time of 1,049.2 seconds, or 17.5 minutes. Traversing the hexagonal version's 25,084 foot road network at an average speed of 23.6 mph takes 724.7 seconds, or 12.1 minutes. The increase in average speed produces a reduction in travel time of 5.4 minutes, which equates to a 30.9% reduction. Instead of reducing travel time, if overall travel time were maintained between subdivision translations, the average speed of the hexagonal

alternative would be 16.3 miles per hour. This indicates that lower posted speed limits could be used without sacrificing travel time when compared to the original Shenandoah subdivision.

	Shenandoah	Hexagonal Shenandoah
No Delay	30.0	30.0
Stop Delay	22.2	-
Stop and Yield Delay	-	23.6

Table 6 - Average speed (mph) for each Shenandoah design.

3.1.4. Safety

Shenandoah exhibits safety benefits when converted to a hexagonal layout through a reduction is vehicular conflict points. Though the number of intersections is comparable between designs, the number of conflict points decreases in the hexagonal version, as shown in Table 7.

	Shenandoah	Hexagonal Shenandoah
# of Y-intersections	-	19
# of T-intersections	19	14
# of 4-way intersections	16	-
Total # of Intersections	**35**	**33**
# of Y-intersection conflict points	-	171
# of T-intersection conflict points	171	126
# of 4-way intersection conflict points	512	-
Total # of conflict points	**683**	**297**

Table 7 - Intersection and conflict point comparison between Shenandoah designs.

Shenandoah contains 683 conflict points compared to the hexagonal design's 297. The translated subdivision contains 2.3 times fewer conflict points than the original.

The possibility of reducing travel speed due to increased travel efficiency combined with a reduction in intersection conflict points underlie the safety benefits of a hexagonal subdivision design.

3.2. The Springbrook Translation

Figure 6 - Original and hexagonal versions of Springbrook.

3.2.1. Land Use Comparison

Springbrook and its hexagonal translation are shown in Figure 6**.** Land use characteristics of Springbrook and its hexagonal complement are illustrated in Table 8 and Table 9.

	Springbrook	**Hexagonal Springbrook**
# of Parcels	196	196
Minimum Parcel Size (ft²)	4,064	5,618
Mean Parcel Size (ft²)	11,618	11,806
Median Parcel Size (ft²)	10,621	10,649
Maximum Parcel Size (ft²)	36,142	36,142

Table 8 - Area (ft²) distribution comparison between Springbrook designs.

	Springbrook	Hexagonal Springbrook
Residential	2,277,214	2,313,983
Non-Residential	791,806	901,547
Right-of-Way	683,841	537,331
Total	3,752,861	3,752,861

Table 9 - Area (ft^2) distribution comparison between Springbrook designs.

The quantity of parcels is maintained at 196 during the conversion. The translation yields increases in minimum, median, and mean parcel sizes. The resulting average parcel size is 11,806 ft^2, compared to Springbrook's original average of 11,618 ft^2. Lot sizes increased by an average of 188 ft^2. Residential area increased by 36,769 ft^2 as a reflection of larger average parcel sizes. Right-of-way area decreased 146,510 ft^2 due to fewer roadways being required to serve the 196 parcels. The 109,741 ft^2 difference in residential and right-of-way areas was reallocated for non-residential use, principally additions adjacent to the floodplain greenway area.

3.2.2. Infrastructure Comparison

	Springbrook	Hexagonal Springbrook
Length of Roads (ft)	11,692	9,136
Length of Road per Parcel (ft)	59.7	46.6

Table 10 - Infrastructure comparison between Springbrook designs.

	Springbrook	Hexagonal Springbrook
Development Cost ($/ft of road)	176	176
Development Cost per Parcel ($)	10,507	8,202
Total Development Cost ($)	2,057,792	1,607,936

Table 11 - Development cost comparison between Springbrook designs.

There are several attribute reductions involved in translating Springbrook to a similar hexagonal version, as shown in Table 10 and Table 11. One is the reduction in road length from 11,692 linear feet to 9,136. That reflects a 21.9% reduction in road and related infrastructure costs. The development cost per parcel decreases from $10,507 to $8,202, a $2,305 reduction, as a result of the translation. Based upon established development costs for College Station, the price of constructing Springbrook cost approximately $2,057,792. The hexagonal version would cost $1,607,936. That is a cost savings of $449,856 to the developer.

3.2.3. Travel Efficiency Comparison

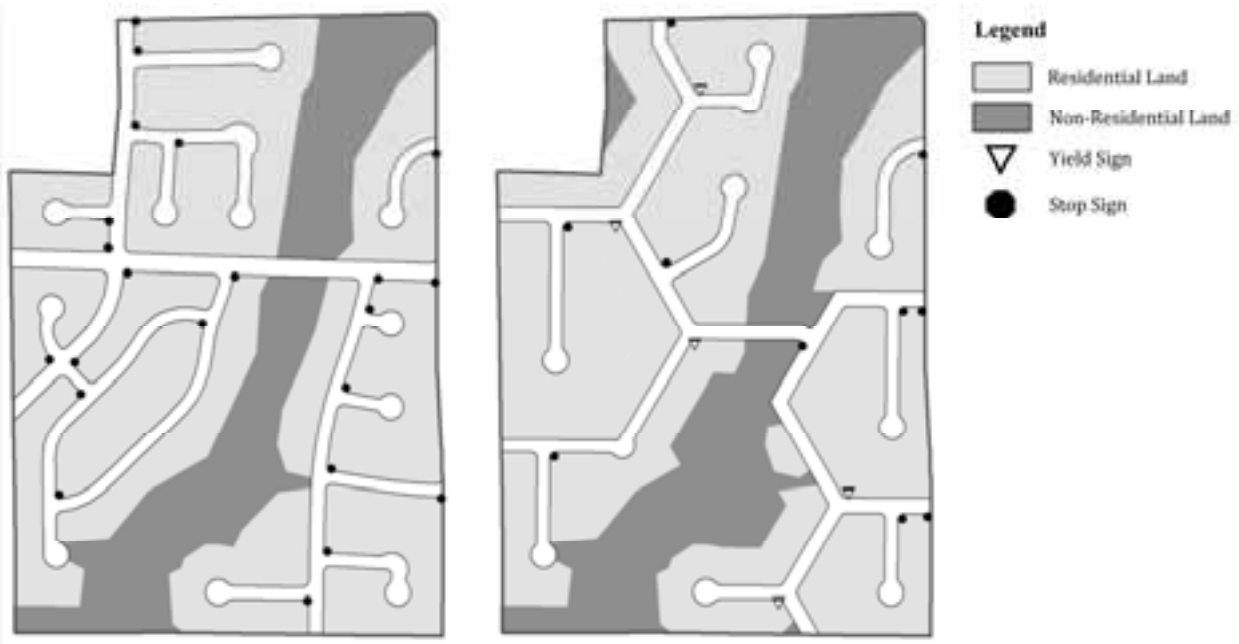

Figure 7 - Stop and Yield-controlled intersections for each version of Springbrook.

The placement of Stop signs for Springbrook and Yield signs for the translated version is show in Figure 7. Similar to Shenandoah, the placement of intersection controls is in part dictated by the roadway classifications. The classifications for Springbrook and its hexagonal counterpart are show in Figure 8.

Figure 8 - Roadway Classification for each Springbrook design.

Optimal speed in Springbrook, assuming no delay, is 30 miles per hour, as determined by each street segment's speed limit and functional classification. The results, shown in Table 12, show an increase in travel efficiency in a development using Stop and Yield signs compared to one that solely utilizes Stop signs. The average speed for the built Springbrook subdivision, calculated with a 7.9 second delay at each stop sign, is 21.0 mph. The hexagonal version of Springbrook, utilizing mixed intersection controls has an average speed of 21.9 mph. That is .9 mph greater than the current version. Traversing Springbrook's 11,692 ft. of roadways at an average of 21.0 mph yields an overall drive time of 379.6 seconds, or 6.3 minutes. Accomplishing the same feat with the hexagonal version's 9,136 ft. of roadways at an average speed of 21.9 mph takes 284.4 seconds, or 4.7 minutes. The increased speeds produce an overall reduction of 1.6 minutes which translates into a 25.4% reduction in travel time. If overall travel time were maintained between subdivision designs, the average speed of the hexagonal iteration

would be 16.4 miles per hour. This indicates that lower speed limits could be utilized without forfeiting travel time when compared to the established Springbrook neighborhood.

	Springbrook	Hexagonal Springbrook
No Delay	30.0	30.0
Stop Delay	21.1	-
Stop and Yield Delay	-	21.9

Table 12 - Average Speed (mph) for each Springbrook design.

3.2.4. Safety Comparison

	Springbrook	Hexagonal Springbrook
# of Y-intersections	-	5
# of T-intersections	13	6
# of 4-way intersections	2	-
Total # of Intersections	**15**	**11**
# of Y-intersection conflict points	-	45
# of T-intersection conflict points	117	54
# of 4-way intersection conflict points	64	-
Total # of conflict points	**181**	**99**

Table 13 - Intersection and conflict point comparison between Springbrook designs.

Table 13 illustrates the results pertaining to intersection type and number, along with the count of conflict points, for each subdivision design. The hexagonal translation results in a decrease of the total number of intersection from 15 to 11. In the case of Springbrook, the real-world version has 181 conflict points and its hexagonal counterpart has just 99. These results indicate that the hexagonal version has 1.8 times fewer conflict points as the original version.

4. Conclusion

Hexagonal planning is an aspect of urban design that has been ignored for more than half a century. From the 1930s until today, it has fallen by the wayside in favor of the ubiquitous loop and cul-de-sac design that permeates the American suburbanscape. The loop and cul-de-sac has been traditionally viewed as the most economic, safe, and livable alternative to the standard grid street network for residential neighborhoods.

The results illustrate a decrease in necessary infrastructure leading to lower development costs, and an increase in travel efficiency by altering intersection controls and allowing for either increased travel speed or improved safety by reducing speeds without sacrificing travel time when compared to the original subdivision designs while additionally reducing the number of intersection conflict points. Translating two subdivisions in College Station, Texas, from standard curvilinear street designs to hexagonal designs while a maintaining parcel count, existing subdivision boundaries, accounting for natural features, and conforming to modern subdivision regulations, has substantial implications towards realizing the benefits of hexagonal design.

The crux of the argument for hexagonal planning involves infrastructure utilization, namely the ratio of infrastructure to the area it serves. There is a reduction in both Springbrook and Shenandoah subdivisions over traditional designs, due to the natural geometric properties of the hexagon. The adapted designs contain significantly fewer linear feet of roadways and related infrastructure resulting in a considerable reduction of development costs. Economic benefits would directly affect the developer who would realize less development risk, less initial financial

burden, and greater profitability by an increase in the available land to sell. Ideally, the savings in development costs would be reflected in the purchase price for the homebuyers.

Initial findings establish a promising foundation upon which to build and extend the current knowledge behind the implications and application of hexagonal planning in residential neighborhoods. They provide a glimpse into the possible cost reduction that would be earned by the developers. The data also indicates that travel for the residents within a subdivision could become both safer and more efficient. Travel efficiency is a fundamental part of subdivision integrity. The effectiveness of a neighborhood design is related to how fluid the movement of its travelers is. Yield-controlled intersections provide the opportunity for a level of mobility not available when adhering to Stop-controls. Allowing for the possibility of continual movement instead of stop-start pulses from intersection to intersection enhances the efficiency of travel. Additionally, yield-controls provide less average delay at each intersection when compared to stop signs, 3.6 seconds versus 7.9 seconds respectively. The combination of increased travel efficiency with decreases in the number of intersections and roadway length equate to either a decrease in overall travel time or a reduction in average subdivision travel speed without sacrificing travel time. While it is unreasonable for each driver to traverse the entire neighborhood each trip to realize efficiency gains, analyzing the entire subdivision as a whole illustrates an aspect of the safety improvement gained through travel efficiency at the subdivision level.

4.1 Future Research Possibilities

Some avenues for continued research involve the addition of multiple land use types, mixed-use and higher density development, further analysis and integration of a functional classification system for the roadways, subdivision expansion, and considerations of pedestrian and bicycle movement.

This research focuses on two subdivisions in College Station, Texas that represent the continual trend in subdivision development. They differ in scale, included natural and regulated features, and geometric foundation with Shenandoah being based upon a standard grid foundation and Springbrook being based upon a traditional curvilinear, loop, and cul-de-sac design. Other neighborhoods with varying natural and imposed features and different subdivision regulations should be attempted fully realize the potential of hexagonal design as a flexible and adaptable alternative to modern subdivision design practices.

It may be necessary to adapt the road hierarchy commonly implemented in current planning practice to accommodate a hexagonal road network. The symmetry of a honeycomb street design allows for an increased number of alternative routes with the same length. The designation of local street, minor collector, or major collector within subdivisions could be dictated by speed limits and Yield control placement. A wider road with little or no Yield controls and a higher speed limit could mimic the functionality of a minor or major collector. Determining proper functionality and controls is one important area for subsequent research. In addition to street function, street naming convention should also be visited. As a continuation along a path in a hexagonal design, whether horizontal, vertical, or diagonal, could be perceived as traveling on

the same roadway due to the geometric properties of a hexagon, determining the most functional method of naming streets to facilitate way-finding is a priority. One design consideration to assist with way-finding would be to adopt round-abouts with circular islands at each three-legged intersection with public art installations such as statues, sculptures, or fountains to provide unique landmarks while enhancing the sense of place or with distinctive landscaping (Breitbart and Worden 1994).

Another opportunity for further research is one in which emphasis is placed on developing pedestrian and bicycle friendly infrastructure coinciding with traffic calming methods. This could be done in conjunction with the safety aspects of the design.

An avenue for further studies relates to subdivision expansion. The neighborhood translations used in this research are based upon the existing subdivision boundaries. Designing additional subdivision phases which seamlessly integrate with a hexagonal network would further demonstrate the flexibility and adaptability of honeycomb design to accommodate both the present and future civic needs.

Presently, improvement over the curvilinear, cul-de-sac design can be manifested by a practical hexagonal alternative, in terms of ability to lower construction costs by reducing infrastructure, improve safety by reducing the number of conflict points, and increase travel efficiency. The cumulative improvement of hexagonal design over its traditional counterpart demonstrates the validity of hexagonal design as a practical alternative to today’s practices.

These results, exemplifying increases in safety, travel efficiently, and reductions in development costs encourage the use of hexagonal planning as a valid alternative to current methods. The neighborhood variations presented in this research illustrate the connection between familiar and novel aspects of subdivision design by capturing the established qualities of traditional neighborhoods and transferring them upon a hexagonal foundation. The adoption of hexagonal design has implications on many different levels; the least of them is to provide a real glimpse of the possibilities of change. Curvilinear, loop and cul-de-sac designs are a trend, a tired habit of conventional planning practice. Hexagonal alternatives are adaptable to natural and political constraints, demonstrate substantial economic benefits, promote a positive living environment, and are fundamentally sound.

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