STAKEHOLDERS’ PERCEPTIONS ON THE DESIGN AND FEASIBILITY OF THE FUSED GRID STREET NETWORK PATTERN

by

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ABSTRACT

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The fused grid is a newly developed street network pattern for laying out neighborhoods and districts (Grammenos 2002). It uses the fusion of two traditional North American street designs: the traditional nineteenth-century grid and the conventional curvilinear pattern of looped streets and cul-de-sacs utilized in modern suburbia (Grammenos 2004). In the twenty-first century, two cities in Canada -- Calgary, Alberta and Stratford, Ontario -- adopted this model for their neighborhoods. The site in Calgary have been adopted, implemented and is currently under construction. The site in Stratford have been adopted but not implemented. Although the two sites adopted ideas and concepts, there is little reported in the scholarly literature about the design and feasibility of the fused grid.

This research assessed the opinions of design and planning professionals and other experts on the design and feasibility of the fused grid street network pattern. The research specifically focused on the design of the fused grid and how it affects the physical realm, as well as its feasibility and adaptation.
The research used qualitative research methods and included in-depth telephone interviews (Taylor and Bogdan 1984). The research also benefited from case study documentation techniques (Marcus et al 1998) as well as the review of relevant literature and secondary data. Snowball sampling (Castillo 2009) was used to select design and planning professionals and experts to interview. Data are analyzed using the grounded theory approach (Taylor and Bogdan 1998).

The results illustrate that most interviewees find the fused grid design promising because of the advantages it offers such as pedestrian connectivity and proximity to open spaces. However, interviewees believe that it may have limited feasibility because existing case studies are too new to yield a sufficient result in terms of economic investment. Nevertheless, interviewees also suggest that the fused grid is an excellent model for any city to adopt because it provides many benefits and reduces dependency on automobiles for short distance trips. The topic is significant to landscape architecture, because the fused grid offers opportunities for design and planning professionals to be involved in the early process of land planning, opening doors to allow innovative design of storm water management, linear parks that connect one cul-de-sac to another, as well as other green space infrastructures.
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CHAPTER 1
INTRODUCTION

The fused grid is a newly developed street network pattern for laying out neighborhoods and districts (Grammenos 2002). The term is derived from the "fusion" of two traditional designs: the traditional grid pattern and the conventional loop and cul-de-sac pattern of the modern suburb (Grammenos 2002). There are currently two documented case studies in two Canadian cities, Calgary, Alberta and Stratford, Ontario, wherein communities have adopted the fused grid model. Both cities seek a new land use and street pattern to help reduce the impact of development on the environment, while at the same time increasing the quality of life for their residents (Grammenos et al 2011). Yet, very little has been covered in the scholarly literature in regards to the design and feasibility of the fused grid.

The Canada Mortgage and Housing Corporation (CMHC) began promoting the fused grid neighborhood and district model to municipalities, developers and planners in 2003 (Grammenos 2008). This thesis takes a step further to seek the perceptions from stakeholders on the design and feasibility of the fused grid. The selected list of participants are professionals who have been involved with the design, planning and development of the fused grid, or, who can give their perceptions on the design principles based on their professional experience and familiarity with the topic.

1.1 Background

Alexander stated that to "...re-establish and maintain the proper connection between city and country, and yet maintain the density of urban interactions, it will be necessary to stretch out the urbanized area in to long sinuous fingers which extend into the farmland..." (Alexander et al 1977 p. 24). See Figure 1.1 for the interlocking fingers of farmland and urban land.
Traditionally, the street networks and land use have shaped how a neighborhood and community has thrived and flourished. From there, blocks were created to provide appropriate orientation for dwellings. Buildings and public spaces were organized in the arrangement of streets because they provided circulation for people and vehicles without the interference with the orientation of dwellings (Gallion and Eisner 1963).

Several older neighborhoods in Europe and North America share the same characteristics with the fused grid such as Vauban in Freiburg, Germany, Portland, Oregon and Savannah, Georgia (Grammenos et al 2011). Portland and Savannah both share the orthogonal geometry with the fused grid. The Savannah grid shares the cellular structure aspect and the systematic inclusion of an open green space within the bounds of a neighborhood.

Existing literature suggests that the fused grid offers many benefits (Grammenos 2008; Grammenos et al 2005; Grammenos and Gregory 2004; Grammenos and Pidgeon 2005). One of those benefits includes pedestrian connectivity. The designs of fused grid allow residents on
one cul-de-sac to walk or bike to another cul-de-sac directly through a green connector. The designs also prevent cars from driving at high speeds through neighborhoods. Alexander stated that the use of closures and diagonal diverters can prevent through traffic (Alexander et al 1977). This method is regarded as a simpler form of the fused grid and is used in Canadian cities like Vancouver and British Columbia, as well as in US cities like Berkeley and Seattle. In the fused grid, street closures and diagonal diverters act as alternatives to green connectors, if implemented into an existing neighborhood.

1.2 Purpose and Objectives

This research assesses the opinions of professionals including designers, planners, developers and others on the design and feasibility of the fused grid street network pattern. The research specifically focuses on the design of the fused grid and how it affects the physical realm as well as its feasibility and adaptation. Also, the research primarily focuses on two case studies in Canada that adopted the system: Calgary, Alberta and Stratford, Ontario. Both cities have sought new land use and street patterns to help reduce the impact of development on the environment while increasing the quality of life for their residents (Grammenos et al 2011).

1.3 Research Questions

The research aims toward assessing the fused grid concept as a whole, and takes a closer look at the two case studies for in-depth analysis. This research primarily answers the following questions:

1. How do fused grid designs affect the physical realm?
2. Is fused grid a feasible design?
3. How adaptable is the fused grid in communities with other design systems?

1.4 Definition of Terms

Arterial: A road that is designed for high-capacity traveling to deliver traffic from collector roads to freeways. Arterial roads usually occur every half mile with intersecting collector(s)
streets. Depending on the density of use of the surrounding development, speed limits are typically between 30 to 50 mph in these areas (Neuman 1992).

Collector: A road that is designed for low-to-moderate-capacities to deliver traffic from local streets to arterial roads. Unlike arterials, collector roads are specifically designed to provide access to residential properties. Signaled intersections or traffic circles are common features of a collector road with speed limits typically between 20 to 35 mph (Neuman 1992).

![Figure 1.2 Road Hierarchy (IBI Group 2007)](image)
Conventional Suburban Design (CSD): A residential development that typically include separated land uses where housing, retail, office and industrial uses are isolated from one another in separate buildings, areas of a development, or areas of a community. Housing is usually further separated into neighborhoods, such that apartments, condominiums and other higher density housing are separate from single family housing. Parks, schools, post offices, health facilities, and other community resources are at a large scale and are separated from other uses to the degree that they can only be reached by motor vehicle (Ford 2010).

Cul-de-sac: A dead-end street with only one inlet/outlet that is typically designed to calm vehicle traffic in a suburban residential neighborhood.

Design: A creative process with intangible elements such as intuition, imagination and creativity (Zeisel 1981). Design is also qualitative and functional arrangement of land (Laurie 1985).

Feasibility: Capable of being done or carried out; Capable of being used or dealt with successfully; suitable (Webster 2012).

Fused grid: A model for neighborhood and district level planning that combines two traditional North American approaches to residential neighborhood planning: the traditional, nineteenth-century grid and the curvilinear pattern of looped streets and cul-de-sacs in modern suburbia (Grammenos 2002).

Green connector: A safe route designed specifically for pedestrians and cyclists that connects throughout a neighborhood (Grammenos 2004).
Grid: A four-way intersection grid used as proxy to reflect "neo-traditional" layout; relates connectivity to a scale from conventional loop and cul-de-sac design to traditional grid design (IBI Group 2007).

![Figure 1.3 Grid Layout](image)

Open space: A place that is readily available for public use where entry is not restricted. Open space ranges from the proximate space of a home to encompass all outdoor spaces of public concern. It also encompasses ideas regarding the out-of-doors, public access and activity, and the relationship between nature and community (Girling and Helphand 1994).

Street network pattern: A network of streets that can be used more than once to create a pattern within a development, which consists of residential, retail and light commercial properties.

Suburban: A residential area, either as part of a city or a separate residential community within commuting distance of a city. Some suburbs have a degree of administrative autonomy and typically have a lower population density than the inner city neighborhoods. The suburb first emerged on a large scale in the 19th and 20th century as a result of improved rail and road transportation.

Traditional Neighborhood Development (TND): A residential development, also known as “new urbanism”, “neo-traditional” or village-style development, that includes a variety of housing types, a mix of land uses, an active center, a walkable design, and often has a
transit option within a compact neighborhood scale area, either as infill in an existing developed area, or as a district scale project (Ford 2010).

Wayfinding: A consistent use and organization of definite sensory cues from the external environment (Lynch 1960), including signage and other graphic communication, clues inherent in the building's spatial grammar, logical space planning, audible communication, tactile elements, and provision for special-needs users (Arthur and Passini 1992).

1.5 Research Methods

This research uses qualitative techniques and case study documentation methods to assess the design and feasibility of the fused grid (Taylor and Bogdan 1998). The researcher seeks out designers, planners, developers and other professionals who are familiar with the fused grid to collect data. The research goes through a process of snowball sampling (Castillo 2009). The key informant was asked for assistance to identify other designers, planners, developers and professionals who may have been involved with the two case studies or have knowledge on the fused grid to participate in the study.

The data are analyzed using the grounded theory approach (Taylor and Bogdan 1998). Through this method, themes and patterns can be developed to define each interviewee's perceptions on the design and feasibility of the fused grid. As Taylor and Bogdan have stated, there are "no guidelines in qualitative research for determining how many instances are necessary to support a conclusion or interpretation" (Taylor et al 1998 p. 156). Instead, each of the interview questions are open-ended to allow the researcher to engage in an in-depth discussion with each interviewee. Through the grounded theory approach, the researcher seeks to discover theories, concepts, hypotheses and propositions that are directly taken from the data.
1.6 Significance and Limitations of Study

As the human population continues to grow rapidly, the way society divides and uses the land is critically important to accommodate the growth. Automobile dependency is likely to increase with the current land planning and street patterns that typically occur in cities around the world, particularly in North America. It is not unusual to make a twenty minute commute by car to travel a one mile distance. By having alternative modes of transportation to work, or to get from point A to point B, the human population can be spread apart, rather than compacting together on one vehicular road.

With the introduction of the fused grid in 2002 (Grammenos 2002), this street network model claimed to provide a safer route for pedestrians as it shifts vehicular access on a separate path and reduces the number of four-way intersections which are prone to traffic collisions. The fused grid concept creates many open spaces and green connectors that are aimed at providing a healthier and more sustainable lifestyle (Grammenos 2008). The transformation of the grid allows the residents of each neighborhood an ease of access to local parks without conflicting with vehicles racing through the streets at 40 miles per hour as often occurs in a typical suburban development.

The purpose of this research is to systematically understand the design and feasibility of the fused grid based on the two case studies so that the findings of the research are informative for future studies and therefore aid in the possible adoption of the fused grid in other cities, particularly in the United States. However, there are limitations to this study. The two cities that have adopted the fused grid are geographically far from the location of the researcher, creating a setback for collecting observation data. One of the two cities that have started construction of the fused grid have not yet completed the construction, therefore creating another limit on secondary map analysis.
1.7 Summary

This research is intended to be a point of reference for systematic exploration of the design, feasibility, and adaptation of the fused grid. It is to help inform future researchers with a set of data collected and with the analysis conducted in this thesis. By understanding the design and feasibility of the fused grid and its benefits, designers, planners and developers can be better informed of another street network pattern when making decisions while planning a new suburban neighborhood development.

The format of this thesis is organized into five major chapters: 1) Introduction, 2) Literature Review, 3) Research Methods, 4) Analysis and Findings, and 5) Conclusions. The first chapter, Introduction, identifies the problem, describes the research objectives and the significance of the fused grid. Chapter 2, Literature Review, focuses on street network patterns and their feasibility and reviews current studies of the fused grid model that has been adopted by Calgary, Alberta and Stratford, Ontario. Chapter 3, Research Methods, includes the qualitative methodology adopted to carry out the research as well as its significance and limitations. Chapter 4, Analysis and Findings, provides results from interviews with designers, planners, developers and other professionals on their perceptions of the fused grid. The final chapter, Conclusion, discusses the significance of the findings, the relevance to the profession of landscape architecture, and suggestions for future research.
CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The literature review focuses on the design and feasibility of varying street network patterns adopted throughout the past few decades as well as current studies of the fused grid (Grammenos 2008; Grammenos et al 2005; Grammenos and Gregory 2004; Grammenos and Pidgeon 2005). The research reviews how street networks came about, and what influenced their transformations over the centuries. There is also a brief review of examples of other types of development around the world, whose land use patterns have been influenced by street patterns and how that shaped their community. Lastly, the review of literature focuses on two case studies in two Canadian cities that have adopted the fused grid into their development plan.

2.2 Critics’ Perception on Design and Planning of Suburbs

Suburbia neighborhood planning has been auto-centric, as scholars such as Newman and Kenworthy (1999) have stated. Other critics have also argued that the dependency on the automobile goes against good neighborhood planning (Proctor 2008). Land-use planning in North America, primarily the United States, is informed by two network patterns; the traditional city rectilinear grid (gridiron), and the conventional suburbia cul-de-sac (Ford 2010). The gridiron was widely adopted into the suburban neighborhood when communities were platted by incremental residential additions (Girling and Helphand 1994). The grid is classically simple and comprehensible, but has often been accused of being boring (Girling et al 1994). The curvilinear pattern, on the other hand, represents rural paths and often is associated with "nature" with the perception that it conforms to the contours of topography (Girling et al 1994).
Architect and urban planner, Fanis Grammenos, decided to launch a quest to direct planners in the direction of yielding to the pedestrian. The fused grid model sprung up because he "felt a discomfort with incongruities, contradictions and oversimplifications", and just had the urge to "get the pieces to match" (Grammenos 2008 p.16). However, the fused grid model was not the only street network pattern that attempts to separate pedestrians from moving cars. The Public Commission of Western Australia proposed an initiative in regards to structuring urban space that won a Congress for New Urbanism award. Architect, urban designer and urban planner, Peter Calthorpe, also proposed a transportation network model for urban growth. The Fused Grid tried to translate Alexander's ideas, and as a result, the design attempts to satisfy all the criteria regarding health, safety, delight, sociability and cost-efficiency (Grammenos 2008).

2.3 Design and Street Pattern

Five street patterns have gradually adapted to support vehicular transportations:

1) gridiron, 2) fragmented parallel, 3) warped parallel, 4) loops and lollipops and 5) lollipops on a stick (Southworth 1997). The different street patterns are shown in Figure 2.1. The gridiron, also known as the Hippodamian plan, was introduced in the early 1900s, in which, streets run at right angles to each other (Alexander et al 1977). The fragmented parallel was introduced in the 1950s and allow for longer streets to occur. A decade later, the warped parallel was established. In 1970, the loops and lollipops were put into practice to aim for a quieter neighborhood. In 1980, lollipops on a stick, also known as cul-de-sacs, have become the popular new residential development (Galion 1986).

Alexander's definition of a pattern, "Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem in such a way that you can use this solution a million times over without even doing it the same way twice" (Alexander et al 1977 appendix x). He states that, like all languages, a pattern language has vocabulary, syntax and grammar. A pattern language, however, is typically applied to complex activities other than communication. In design, the vocabulary is a collection
of "solutions" to a problem in a particular topic. Each of the solutions would include a "syntax" that describes where the solution fits in a comprehensive design. The solution includes "grammar" which describes how the problem was solved (Alexander et al. 1968).

A pattern is essentially a language that describes a solution to a design. Street networks can physically influence how people move about within a city and can certainly influence the way in which people become familiar with particular sections of a city (Beavon et al 1994).

| Street Patterns | Gridiron (c. 1900) | Fragmented Parallel (c. 1950) | Warped Parallel (c. 1960) | Loops and Lollipops (c. 1970) | Lollipops on a Stick (c. 1980) |

Figure 2.1 Evolution of Street Patterns (Adapted from Southworth and Owens 1993)

2.3.1 The Influence of Street Pattern on Land-Use Planning

Throughout history, there have been many notable cities whose communities are successfully planned with the health of the public, pedestrian connectivity and vehicular access in mind. The following are some of the communities that set the way for future approaches to street and land planning.

- The Garden City (1903). A concept developed by Ebenezer Howard in 1898 in response to the extreme wealth and poverty in Britain's nineteenth-century industrialized cities (Howard 1902). Howard aimed to offer ordinary people a third alternative to the town-or-country quandary, the town-country magnet would provide "...all the advantages of the most energetic and active town, all the beauty and delight of the country..." (Girling and Helphand 1994, p. 55). One significant feature of the Garden City is that it should be regionally dispersed through living and working. The city
should be limited in size and population. Essentially, Howard's Garden Cities formed the
gem of Western new town theory.

Howard envisioned the Garden City to have dwellings distributed about a large central
court in which the public buildings would be located. Shopping centers would be on the
edge of town and industries would be on the outskirts. The city would have a population
of about 30,000 people in an area of 1,000 acres. The entire city would be surrounded
with a permanent belt of agricultural land of 5,000 acres (Gallion and Eisner 1963).

Figure 2.2 The Garden City Diagram by Ebenezer Howard, 1902 (Girling and Helphand
1994)
Radburn (1929). This community was known as "A Town Planned for the Motor Age" and also "A Town for Children" (Girling and Helphand 1994 p. 60). However, only a portion of the plan was built. Inspired by the "garden city" idea, planners Henry Wright and Clarence Stein and landscape architect Marjorie Cautley planned the community for a vacant site in New Jersey located within commuting distance from New York City (Gallion and Eisner 1963). According to Girling and Helphand, there are five major components of the Radburn:

1. The Superblock;
2. Specialized roads planned and built for one use instead of all uses;
3. Complete separation of pedestrian and automobiles;
4. Houses turned around; and
5. Park as the backbone.

Each Radburn house faces both a pedestrian walkway and a cul-de-sac street that consists of 15 to 20 other houses. The culs-de-sac wraps around a green park spine to create a superblock of 35 to 50 acres which are served by arterial roads (Girling et al 1994). Overlapping these superblocks create neighborhoods with a half-mile radius where a school can be located. Each neighborhood can also be serviced by a local shopping center. The goal of the cul-de-sac, the walkways, the superblock, the park and the neighborhood units is to have a face-to-face community.

Radburn idea aimed to create a town in which people could live peacefully with the automobile -- or rather in spite of it. Each Radburn house, either single or attached, had two faces. At the core, the two faces of the Radburn house attempts to combine the city and country to compensate for the suburban polarities. In many ways, the Radburn represents the desire to return those lost gardens to the landscape (Girling et al Helphand 1994).
Broadacre City. Designed in the 1930s by architect Frank Lloyd Wright, Broadacre City consists of united roads yet separated areas and functions. It is intentionally designed to diminish the boundary between landscape and cityscape. Features of the Broadacre include a grand scale, where a city is built around a module of one acre per household (Girling and Helphand 1994). The home is the most important unit in the city and having the one acre lot allows for intensive gardening. These were the Broadacre's basic building blocks. Wright stated that the home would be an indoor garden, while the
garden would be an outdoor house. He also clearly stated that Broadacre City is not a suburban dormitory. The land uses are integrated, the agriculture is integral to the community, and industry and commerce were equally present (Girling et al 1994). Thus, the plan is, in many respects, a true precursor to more recent sustainable city proposals.

Figure 2.4 Broadacre City (Source: Frank L. Wright 1932)
Conventional Suburban Development. This type of development is shaped largely by zoning practices that require a clear separate of uses. Building blocks of development are distributed across communities in single-use pods consisting of office space, housing, and shopping. The one feature that connects these distinct uses is a road network that funnels traffic from small neighborhood or office-park streets onto larger collector or arterial roads. This type of layout forces all traffic onto high-capacity roads that in turn, creates congestion and makes walking or biking difficult because of heavy traffic and lack of direct routes (Sobel, Anderson and Shipman 2011). As a result, the lack of connectivity and alternative routes often leave residents little option but to drive.

The design of a CSD development usually reflects the following characteristics:

1. Dispersed form with no distinct edge that eventually disturbs the majority of the site’s buildable land;
2. Single-use pods, containing one kind of lot and a building type in each;
3. One way in and out of each pod;
4. Garage doors and garbage pickup facing the street;
5. Large blocks with irregular shapes and culs-de-sac;
6. Open space in the residual "left-over" land between pods, and around regulated wetlands; and
7. Strip mall shopping centers with big box retail and large parking lots between the buildings and the street (Ford 2010).
Traditional Neighborhood Development. While there is no single model for a traditional neighborhood development, there are several principles that help define this development type: Compact development, mixed use, multiple modes of transportation, and responsiveness to cultural and environmental context. Several examples of this type of development can be seen in Monarch Village in Stockbridge, GA, Vermillion in Huntersville, North Carolina, First Ward in Charlotte, North Carolina, Glenwood Development in Atlanta, Georgia, and Huntersville Common in Cornelius, North Carolina.

The design of a TND development usually reflects the following characteristics:

1. Compact form with a distinct edge yielding a large contiguous preserved open space;
2. Mixing of land uses;
3. Complete neighborhoods proportioned generally according to a 5 minute walking distances;
4. Grid network of interconnected streets with short, walkable blocks and multiple route choices;
5. Alleys with garage access and rear garbage pickup;
6. On street parking and shared parking strategies to reduce parking lot size; and
7. Community parks, squares, and open spaces faced by fronts of buildings and located within walking distance of residential homes (Ford 2010).

Figure 2.6 Traditional Neighborhood Development (Source: Dover, Kohl and Partners 2010)

2.4 Design and Feasibility

Cities throughout the world have been luring people with the idea of working in the city but living in the country (Girling and Helphand 1994). When the American suburbs were born, many people were attracted to the "golden mean" of city and country, believing they could have the best of both worlds in the new suburban development (Girling et al 1994). Designers, planners, architects and developers have created different types of development whose designs may be successful in one city but were not successful in another city, depending on the geographic location.

Why were some development models successful while some were not? What factors had an effect on the feasibility that prohibited or permitted those designs to work? The Garden City, for example, was successfully planned according to Howard's designs (Gallion and Eisner
1963). His emphasis on obtaining the greenbelt area and having a controlled population density became an integral part of suburban and city planning. In the case of Radburn in New Jersey, the plan did not grow beyond the limits of the initial phase. Critics implied that it failed to realize the holistic vision of the Regional Planning Association of America (Martin 2001). The development process occurred at the onset of the Great Depression, causing critics to question the reasons for its failure (Gallion et al 1963; Martin 2001).

2.5 Introduction of the Fused Grid

The concept of the fused grid was developed by a Senior Canada Mortgage and Housing Corporation (CMHC) Researcher, Fanis Grammenos, to addresses environmental and quality of life issues. The term ‘fused grid’ resulted from the fusion of the inner city grids of downtown neighborhoods and the so-called crescents and culs-de-sac of suburbia. The traditional city grid is easy to navigate and is direct; however, there are many four-point intersections in residential areas that make walking less comfortable and less safe. For centuries, planners have been praised for their clever use of real estate through the use of culs-de-sac, but the trade-off is that culs-de-sac are notoriously difficult to traverse by foot (Carpenter and Fick 2005). Traveling from point A to point B requires a convoluted journey that also consumes time. As a result, pedestrians choose to ride in their cars instead (Carpenter et al 2005).

2.5.1 Transformation of the Grid

Living in a period where humans are constantly surrounded by pollution, there is a strong interest for decreasing the dependency on vehicular transportation, especially for short distance traveling. In a new fused grid residential development, paving areas for vehicles can be reduced and allow the opportunity for a foot path to connect from one street to another. Figures 2.7 and 2.8 show the removal of street sections to create public open space. The transformation of the grid created open spaces, hence giving neighborhood residents the benefit of being closer in proximity to parks.
2.6 Design Concepts of the Fused Grid Model

As addressed earlier, the fused grid model aims to produce a high level of pedestrian connectivity, and at the same time, limits the amount of automobile through-traffic within the residential areas. This is accomplished by shifting the majority of traffic to continuous through-traffic roads located around the perimeter of the neighborhood while making streets discontinuous within the neighborhood.

An important element in the success of the fused grid is to strategically place the footpaths, linear parks and open spaces. This ensures a continuous pedestrian network within the neighborhood. High possible results of the fused grid result in slower traffic around the residential area, which allows pedestrians to flow uninterrupted. Pedestrians are then provided with pleasant walking routes to parks, transit facilities, local stores and amenities (Grammenos 2008).
Abstractions of the fused grid layout are as follows:

- **Quadrants:** sixteen (16) hectares (39.5 acres) of residential area, which are served internally by culs-de-sac and loops to discourage through traffic;
- **Neighborhoods:** sixty-four (64) hectares (158 acres), made up of 4 quadrants and bound by arterials and collectors; and
- **Districts:** 256 hectares (632.5 acres), made up of four (4) neighborhoods and bound by arterials (IBI Group 2007).

The fused grid is comprised of collector streets linking local traffic to arterial streets encompassing a half-mile grid. Figure 2.9 represents the concepts of the fused grid, showing four areas that are roughly forty (40) acres in size (about 1,300 feet by 1,300 feet), forming four distinct neighborhoods. Within each neighborhood, through traffic is eliminated by the layout of crescents and culs-de-sac. A continuous pedestrian path system, also referred to as green connectors, provide direct access to public open space, public transit, retail and community facilities. Intensive land uses for purposes such as schools, community facilities, retail establishment, and high-density residential areas such as apartments are located between two parallel collector or arterial roads that are encouraged to mix to accommodate density. "The plan provides efficient vehicular traffic, without sacrificing safety and convenience for pedestrians" (Grammenos and Gregory 2004, p.6). Essentially, the fused grid gives way to flexibility for repetition of the grid, but without having the same neighborhoods, as there are many different ways to lay out the street patterns.
Figure 2.9 The Fused Grid Concept (Grammenos and Gregory 2004)
2.7 Fused Grid Case Studies

In this section, two case studies are discussed in detail to set a baseline of knowledge before interviewing participants. The first case study involves a community in Calgary, Alberta, by the name of Saddleton, which has adopted and implemented the fused grid and is currently under construction. The second case study is located in Stratford, Ontario. The fused grid has been adopted into the developmental plan, but has not been implemented.
2.7.1 Calgary, Alberta

In 2004, two years after the introduction of the fused grid theory, a developer by the name of Genesis Land Development collaborated with Canada Mortgage and Housing Corporation to apply the model to a parcel of their land in northeast of Calgary. The partnership satisfied both the private and public sector with a preliminary site plan that reflected the fused grid principles (Grammenos 2008). The preliminary design work began in 2006 with the intention of achieving efficiency, quality and a reduced impact to the environment (Grammenos 2008).

Saddleton, the name of this new development, is a 64 hectare (160 acre) subdivision plan that adopted the fused grid model. The designs consists of open spaces for recreational activities, pedestrian connectors to all parts of the neighborhoods, storm water management systems and opportunities for developers to increase density as needed (Grammenos 2008).
The fused grid is one solution for planning neighborhoods and districts that has been designed to reduce the impact of development on the environment, while maintaining or increasing the quality of life for residents. Table 2.1 shows the elements of the fused grid that have been incorporated into the Saddleton plan to respond to a number of concerns raised by the municipals of Calgary. Today, the fused grid development plan has been implemented and is under construction.
Figure 2.12 Saddleton Development Concept Plan in Calgary, Alberta (Grammenos 2008)
Table 2.1 Fused Grid Elements in Saddleton and How They Respond to Issues (Grammenos 2008)

<table>
<thead>
<tr>
<th>Initiative or Solution</th>
<th>Addresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic control and calming</td>
<td>Noise pollution</td>
</tr>
<tr>
<td></td>
<td>Air quality</td>
</tr>
<tr>
<td></td>
<td>Street (for both drivers and pedestrians)</td>
</tr>
<tr>
<td>Alternative street design (Fused Grid)</td>
<td>Pedestrian and cyclist safety</td>
</tr>
<tr>
<td></td>
<td>Noise pollution</td>
</tr>
<tr>
<td></td>
<td>Air quality</td>
</tr>
<tr>
<td></td>
<td>Water quality (more permeable area)</td>
</tr>
<tr>
<td></td>
<td>Physical health (encourages walking)</td>
</tr>
<tr>
<td></td>
<td>Mental health/social development</td>
</tr>
<tr>
<td>Green space, water retention</td>
<td>Noise pollution</td>
</tr>
<tr>
<td></td>
<td>Air quality</td>
</tr>
<tr>
<td></td>
<td>Water quality</td>
</tr>
<tr>
<td></td>
<td>Stress and mental health</td>
</tr>
<tr>
<td>Optimal development density and mixed use</td>
<td>Air quality</td>
</tr>
<tr>
<td></td>
<td>Fewer car trips</td>
</tr>
<tr>
<td></td>
<td>Physical health</td>
</tr>
<tr>
<td></td>
<td>Encourages walking</td>
</tr>
<tr>
<td>Bicycle/pedestrian infrastructure</td>
<td>Air quality (fewer car tips)</td>
</tr>
<tr>
<td></td>
<td>Pedestrian and cyclist safety</td>
</tr>
<tr>
<td></td>
<td>Noise pollution (traffic reduction)</td>
</tr>
<tr>
<td></td>
<td>Physical and mental health</td>
</tr>
</tbody>
</table>

2.7.2 Stratford, Ontario

Stratford, Ontario is the second city to test the concept of the fused grid. Like many cities, Stratford reaches out and searches for a quality of life in an effort to maintain a well, functioning, vibrant city. During the conceptual design phase, the planning team, in consultation with the City, as well as in response to public participation, developed three concepts for the city council's considerations. In this case, the fused grid serves as a design alternative to the Northeast Secondary Plan study area in the City of Stratford to compare against two other design proposals that featured more conventional planning.

The first design alternative (Figure 2.14) is a conventional suburban plan that consists of a curvilinear road pattern and provides a hierarchy between the arterial, collector, and local
streets. More intensive land uses and community land uses are placed at the intersection of collector and arterial roads. The open spaces are dispersed throughout the community to provide walking distances that are in close proximity to residents (Grammenos and Gregory 2004).

The second design alternative (Figure 2.15) is the fused grid plan. In this case, the planning principles of the fused grid incorporates a central corridor of paired arterial roads and community facilities, including two school sites, a public transit and medium-density residential land uses. The developable land is divided into 40-acre blocks by a grid of collector roads which link to the regional arterial road network. All local streets are either crescents or culs-de-sac, with an area of pedestrian open space in the center of each block to provide accessibility from each street within the block. This plan uses the standard subdivision block depth of 200 feet, while the first alternative design uses varying block depths of 220 to 260 feet (Grammenos and Gregory 2004).

The third design alternative is a hybrid (Figure 2.16), a combination of the conventional suburban plan and the fused grid plan. The plan consists of a central area for community uses and incorporates many of the fused grid principles, such as a grid pattern of minor collector streets. Other features of the fused grid that are also embedded within this hybrid include the internal crescents and culs-de-sac, as well as direct accessibility for pedestrians to open space (Grammenos and Gregory 2004). The hybrid fused grid, however, excludes the twinning roads through the "town center". Each house's yard space is determined by a block dept of 220-270 feet where the lots are generally larger in exurban and rural settings than in cities or fringe subdivisions (Grammenos et al 2004). In this case, "lot depth influences the frequency of streets in a network and consequently the sum of their lengths, as well as the number of blocks and intersections and their impact on connectivity" (Grammenos et al 2004).
Figure 2.13 Site Location in Stratford, Ontario (Google Earth 2012)
Figure 2.14 First Design Alternative: Conventional Suburban Plan (Adapted from Grammenos and Gregory 2004)
Figure 2.15 Second Design Alternative: Fused Grid Plan (Adapted from Grammenos and Gregory 2004)
Figure 2.16 Third Design Alternative: Fused Grid Hybrid (Adapted from Grammenos and Gregory 2004)
2.7.2.1 Design Alternatives Evaluation

Sixteen criteria were identified to assess the three design alternatives for the Northeast Secondary Plan study area in the City of Stratford. Those criteria were based on efficiency, quality of life, and environmental impact and are compared in Table 2.2, 2.3, 2.4, 2.5 and 2.6. Efficiency were taken into consideration of three land-use related quantities: 1) net developable area; 2) saleable frontage; and 3) the percentage of land area used for roads. Road efficiency was also measured by matching projected traffic to the road type to ensure that proposed roads can support the anticipated capacity without under- or over-utilization (Grammenos and Gregory 2004).

Quality of life were taken into account of 1) neighborhood tranquility by measuring the number of crescents and culs-de-sac which are considered more desirable; 2) restfulness by measuring the number of pedestrian intersections that allow residents to get from one street to another; and 3) connectivity by measuring the frequency of block sizes where the larger the blocks, the greater the road lengths. Quality of life also measured the opportunities for direct views to open space from each residential homes and the ease of access to recreational parkland by measuring the shortest path to residential uses (Grammenos et al 2004).

Environmental impact were taken into account of minimizing adverse effects on the natural environment as well as minimizing the risk to residents. These factors include: 1) preservation of the natural habitat that include woodlots, watercourses, floodplains, and wildlife habitat; 2) impact of traffic noise along arterial roads to noise-sensitive land uses; 3) safety for cars that were measured by the percentage of T-intersections; and 4) safety for pedestrians that were measured by the number of road crossings needed to walk to community uses.
### Table 2.2 Block Characteristics and Relation to Street Pattern (Grammenos and Gregory 2004)

<table>
<thead>
<tr>
<th></th>
<th>Block depth (feet)</th>
<th>Street length (feet)</th>
<th>Number of blocks</th>
<th>Number of intersections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional suburban plan</td>
<td>220-270</td>
<td>51,509</td>
<td>44</td>
<td>54</td>
</tr>
<tr>
<td>Fused grid</td>
<td>200</td>
<td>60,121</td>
<td>66</td>
<td>63</td>
</tr>
<tr>
<td>Hybrid</td>
<td>220-270</td>
<td>53,149</td>
<td>53</td>
<td>50</td>
</tr>
</tbody>
</table>

### Table 2.3 Comparison Between Conventional and Fused Grid Alternatives With Respect to Five Criteria of Efficiency (Grammenos and Gregory 2004)

<table>
<thead>
<tr>
<th>Efficiency</th>
<th>Net developable area (acres) (residential)</th>
<th>Net saleable frontage (feet)</th>
<th>Connections to future development (number)</th>
<th>Transit efficient (average distance in feet to bus stop)</th>
<th>Road length (linear feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional suburban plan</td>
<td>205</td>
<td>58,100</td>
<td>0</td>
<td>951</td>
<td>51,509</td>
</tr>
<tr>
<td>Fused grid</td>
<td>200</td>
<td>60,300</td>
<td>5</td>
<td>700</td>
<td>53,150</td>
</tr>
</tbody>
</table>

### Table 2.4 Comparison Between Conventional and Fused Grid Alternatives With Respect to Five Criteria of Quality of Life (Grammenos and Gregory 2004)

<table>
<thead>
<tr>
<th>Quality of life</th>
<th>Tranquility (no. of crescents, cul-de-sacs)</th>
<th>Connectivity (no. of blocks (B), no. of intersections (I))</th>
<th>Pedestrian intersections (no. of non-vehicular intersections)</th>
<th>Access to parkland (average distance to parks in ft)</th>
<th>Direct views of open space from streets (linear feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional suburban plan</td>
<td>13, 6, (19)</td>
<td>B.44 – I.55</td>
<td>14</td>
<td>1,509</td>
<td>10,571</td>
</tr>
<tr>
<td>Fused grid</td>
<td>15, 7, (23)</td>
<td>B.53 – I.50</td>
<td>27</td>
<td>623</td>
<td>12,553</td>
</tr>
</tbody>
</table>
Table 2.5 Frequency of Block Sizes By Size Range As an Indicator of Neighborhood Walkability (Grammenos and Gregory 2004)

<table>
<thead>
<tr>
<th>Plan alternatives</th>
<th>Small to medium block sizes</th>
<th>Large to very large block lengths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 300</td>
<td>300-600</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600-900</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subtotal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>900-1,200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1,200-1,800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;1,800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Conventional suburban plan</td>
<td>9%</td>
<td>32%</td>
</tr>
<tr>
<td></td>
<td>11%</td>
<td>52%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>23%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Fused grid</td>
<td>11%</td>
<td>34%</td>
</tr>
<tr>
<td></td>
<td>28%</td>
<td>73%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 2.6 Percentage of T- and Cross-Intersections As an Indicator of Car and Pedestrian Safety (Grammenos and Gregory 2004)

<table>
<thead>
<tr>
<th>Plan alternative</th>
<th>Total car intersect.</th>
<th>No. of T intersect.</th>
<th>Percent of T intersect.</th>
<th>No. of cross intersect.</th>
<th>Percent of cross intersect.</th>
<th>Total (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional suburban plan</td>
<td>54</td>
<td>50</td>
<td>92%</td>
<td>4</td>
<td>8%</td>
<td>100%</td>
</tr>
<tr>
<td>Fused grid</td>
<td>50</td>
<td>42</td>
<td>84%</td>
<td>8</td>
<td>16%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Figure 2.17 Fused Grid Applied to a New Development in Stratford, Ontario
(Grammenos and Gregory 2004)
In conclusion, the third design alternative, fused grid hybrid, was chosen to be applied to the new development in Stratford as shown in Figure 2.17. The conceptual plan was successfully adopted by the Stratford City Council, but has not been implemented due to one land owner’s unwillingness to develop the land. That particular land owner is essentially the first property owner that would have to develop in order to allow any other development to take place because the property is the first row extension, the first sanitary sewer, and the first water main extension that would be required to service any other land.

2.8 Summary

This chapter described the evolution of street patterns and how it influenced neighborhood and community environments. A review of historic street patterns in relation to various land-use planning models (Garden City, Radburn, Broadacre City, Conventional Suburban Development and Traditional Neighborhood Development) was conducted to address the reciprocal relationship between the two. It also showed how design influenced opportunities for multi-modal transportation networks and green infrastructures that are known to be an important part of contemporary planning strategies. As it is reviewed in this section, the fused grid street network pattern development attempts to reduce the impact on the environment by encouraging more walking and less driving through the fusion of street networks (Grammenos 2002). The two case studies reviewed illustrates its application. Feasibility is also reviewed in relation to design in order to better inform designers, architects and planners of the strengths and weaknesses of the fused grid. In the next chapter, research methodology discusses how data will be collected and how it will be analyzed to assess the design and feasibility of the fused grid.
CHAPTER 3
RESEARCH METHODS

3.1 Introduction

The study primarily focuses on the design and feasibility of the fused grid by using qualitative methods and case study documentation. The goal is to understand the perceptions from different stakeholders, such as designers, planners, developers and other professionals who are involved with the fused grid projects or who have familiarity with the topic. Each participant provides their knowledge and opinions based on their professional expertise and compares the fused grid with two other types of development that they may also be familiar with -- Conventional Suburban Development and Traditional Neighborhood Development.

3.2 Qualitative Approach

The thesis primarily uses qualitative method techniques to answer the questions set forth by the researcher. The study uses in-depth interviews as the primary data collection technique while benefiting from the review of secondary data on the two fused grid case studies in Calgary, Alberta and Stratford, Ontario. The study uses snowball sampling techniques (Castillo 2009) for interviews, and evaluation techniques (Marcus and Francis 1998; Francis 2001) to evaluate design, feasibility and adaptation of fused grid street network pattern.

3.3 Study Location

In order to address the questions raised pertaining to the benefits of the fused grid, two case studies are chosen wherein both have their own challenges. The first case study is located in a neighborhood called Saddleton, in Calgary, Alberta. The city itself has a population of 1,096,833 people in 2011 with a 318 square mile land area (Statistics Canada 2011). The second case study is located in Stratford, Ontario with a population of 30,886 people in 2011 within 10 square miles of land area (Statistics Canada 2011). Both cities were chosen because
they are the first two to adopt the fused grid concept in their development plans. Interviewees are located in various locations of North America.

3.4 Data Collection Methods

The research collects data through two methods: interviews (Taylor and Bogdan 1998) and secondary sources (Francis 2001; Marcus et al 1998). The goal is to understand the perceptions as each participants provide their knowledge and opinions based on their processional expertise. When necessary, a look at secondary sources is required to document the two case studies.

3.4.1 Interviews

Interviews are designed to obtain information on perceptions of current, past and possibly future data (Lincoln and Guba 1985). The study requires that the interview be aimed at key players in the fused grid implementation process that include the designers, planners and possibly the developers. To interview, the research uses snowball sampling, a technique that works like a chain referral. After communicating with the key informant, the researcher asks for assistance to identify others who were involved in a similar process (Castillo 2009).

3.4.1.1 Selecting the Interviewees

The selection of participants is based on the exponential Non-Discriminative Snowball Sampling as shown in Figure 3.1. A short list of interviewee contact information is constructed by contacting Fanis Grammenos, who are well acquainted with individuals involved with or have familiarity with the topic. The next set of interviewees are based on referrals by that list of contacts. There are several advantages of snowball sampling that allows the researcher to reach a population that is difficult to sample when using other sampling methods. The process is comparatively simple and cost-efficient and requires a smaller workforce as compared to other sampling techniques such as randomized and probability sampling.
Figure 3.1 Types of Snowball Sampling (Castillo 2009)

However, there are also disadvantages to snowball sampling. The researcher has little control over the sampling method. The participants that the researcher can obtain rely heavily on the previous participants that were observed. Representativeness of the sample are not guaranteed. Sampling bias also includes a fear of researchers when using this sampling technique (Castillo). Initial participants tend to nominate people that they know well, and because of this factor, it is highly possible that the participants share the same traits and characteristics.

3.4.1.2 Interview Design

Interviews were digitally recorded at the time of the interview. The interviews are than transcribed and translated by the researcher and then destroyed. All interviewee participants
are protected and no identifying information was revealed to assure the anonymity of the participants. IRB approval was received on September 19, 2012 (See Appendix A).

An introduction of the researcher is followed by a description of the study. Interview questions are organized into two parts: the interviewees’ credentials and their perceptions of the fused grid in regards to design and feasibility. The following are planned questions that will hopefully lead into an open-ended interview (See Appendix B for profiling questions):

1.) How does the fused grid compare with other forms of development?

2.) How does a fused grid work when used adjacent to other forms of development?

3.) Is the fused grid a feasible form of design?

4.) What factors affect the adoption of a fused grid in other communities?

3.4.2 Case Studies

The study also follows case study documentation to study each setting by identifying the background, the design and planning aspect of it and the lessons learned from it (Francis 2001; Marcus et al 1998). It should be noted that case studies are limited due to the number of cities that have adopted the fused grid. A look at secondary data included other studies written on the benefits and assessment of fused grid (Frank and Hawkins 2008; Grammenos 2008; Grammenos and Gregory 2004; Grammenos and Pidgeon 2005; IBI Group 2007) to add depth and used as a cross reference to the interview data.

The case studies in the research consist of the two neighborhoods previously discussed in Chapter 2 of the Literature Review. The site in Calgary, Alberta has successfully been adopted and is under construction. It took five years, from conceptualization to plan to city council's approval, and finally to the first construction. Currently, a quarter of the development plan is built out. The Northeast section of Stratford, Ontario has been adopted, but not implemented, due to an issue with one land owner. The case studies in this particular thesis are

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necessary to provide a baseline of information as the researcher interviewed participants. Data were obtained from written articles from the Canada Mortgage Housing Corporation's Research Highlight as well as research documents written by design and transportation firms.

3.5 Analysis and Evaluation Techniques

After the interviews are transcribed, the data get analyzed using the grounded theory approach (Taylor and Bogdan 1998). The researcher reads and re-reads the transcriptions to look for themes and patterns based on conversation topics with each of the interviewees. The researcher also looks for recurring statements, meanings and feelings to discover "...theories, concept, hypotheses and propositions directly from data rather than from a priori assumptions, other research or existing theoretical frameworks..." (Taylor and Bogdan 1998, p. 137). The two case studies are used to support and verify the data in certain circumstances. The researcher looks at the differences and similarities between interview data and case study documents and maps to compare. From there, more themes emerged. The analysis method is shown in Figure 3.2.

Methodologically recording and transcribing the interviews helped to accurately note and dissect responses, which added more depth to the bulk of the research. By personally transcribing the interviews, the researcher remembered each respondents' tone of voice as it was embedded into the mind. During the close reading of the transcriptions, the tone of each respondents would play back in the researcher's mind, slowly creating a sense of character of each interviewee.

It was necessary to refrain from bias and making bold statements to the respondents. It is very critical to ask the questions and listen to the respondents without interjecting one's own views and opinions. That is why it was important to capture each respondent's words in the tone and mood that they were stated. The hope is that the collected data in this research can be a starting point for further research regarding the fused grid, either qualitative or quantitative.
3.6 Methodological Significance and Limitations

This research is limited because there are only two case studies that have adopted the fused grid model. In the same line of limitations, one of the two case studies that have adopted and started the construction of the fused grid is geographically far for the researcher, too far to make personal observations. Therefore the researcher is limited to using maps and secondary data. Interviewees are assumed to have the best knowledge about the sites, places and issues raised in this research. The researcher made a complete effort to contact and gain the interviewees trust; however, their willingness to share their perceptions and opinions is not within control of the researcher.

Figure 3.2 Interview and Case Studies Analysis Method
3.7 Summary

The objective of this study was to seek the opinions of designers, planners, developers and other professionals who were involved with a fused grid project or who have familiarity with the topic in order to assess the design and feasibility of the fused grid as well as its adaptation. The open-ended interviews are designed to provide qualitative data that include a variety of responses. Case studies are used to provide the necessary baseline information for the researcher and to direct respondents’ concerns to current design and planning practices of the fused grid. The following chapter gives detailed analysis and findings as a result of the previously described methodology.
CHAPTER 4
ANALYSIS AND FINDINGS

4.1 Introduction

This chapter provides analysis and findings from the interview data supported by case study findings from two cities in Canada -- Calgary, Alberta and Stratford, Ontario. Collected data were transcribed from interviews and analyzed using the grounded theory as outlined by Taylor and Bogdan, 1998. Additional data acquired from two case studies are used to provide the necessary baseline information for the researcher as well as to ground respondents concerns to the current design and planning practices of the fused grid. Emerging themes are outlined based on the research questions regarding design, feasibility and adaptation of the fused grid, as was set forth in the introduction chapter.

4.2 Participants' Profile

As discussed in Chapter 3, interview participants were derived from a list of names given by Fanis Grammenos, the creator of the fused grid concept. From there, a recruitment email was sent out, followed by a confirmation email. The snowball technique was also employed by asking participants for recommendations of other design professionals who were knowledgeable or who might have an interest in the study of the fused grid (Castillo 2009). The snowball technique yielded two more participants with four others who were either unable to set an interview appointment within the time frame of the research, or who did not respond to the recruitment email.

With the consent of each interviewee, all interviews were conducted by telephone, recorded, and personally transcribed by the researcher. After transcriptions, the interviews were analyzed using the grounded theory approach (Taylor and Bogdan 1998). Interviews were conducted with twelve professionals who have been involved with the design, planning, and
development of the fused grid or who can give their perceptions on the design principles, based on their professional experience and familiarity with the topic. Participants in this research included two developers, five planners, one mayor, two professors with Ph.D’s, one transportation planner and one civil engineer. The twelve participants were interviewed to understand their perceptions on the design and feasibility of the fused grid. The interviews were recorded, transcribed and then analyzed using the grounded theory approach to find related themes among the twelve participants.

4.3 Themes from Data

The grounded theory method was used to identify themes from the collected interview data (Taylor and Bogdan 1998). Through this method, themes were discovered by reading and re-reading the interview transcripts until there were no new themes emerging from the data. It is critical to note that, as Taylor and Bogdan stated, there are “...no guidelines in qualitative research for determining how many instances are necessary to support a conclusion or interpretation. The best insights sometimes come from a small amount of data...” (1998 p. 156). The following themes regarding the design and feasibility of the fused grid discussed in this study have emerged from analysis of the interview transcripts:

- Design and Physical Realm
  - Physical Layout
    - Street Design
      + Wayfinding
      + Vehicle Connections
      + Road Diet
      + Sense of Community
    - Green and Open Space Infrastructure
      + Parks
      + Green Connectors
  - Architecture/Built Space
- Developable Land
- Density
- Green Field vs. Retrofit

- Feasibility
  - Economics
  - Developer's Priority
  - Environmental Setting
  - Maintenance

- Adaptation
  - Governing Body
  - Spreading the Word
  - Alternatives

4.3.1 Design and Physical Realm

4.3.1.1 Physical Layout

Similar to other neighborhood developments mentioned in Chapter 2 of Literature Review, a fused grid design consists of streets and open spaces layouts that have a direct correlation to the way people are socially connected. According to R6, "...road dieting in a fused grid is necessary to encourage walking." Contradicting that, R7 believes that road dieting could cause problems for emergency vehicles when it comes to accessing a neighborhood. Unlike a traditional neighborhood development and a conventional suburban development, the fused grid has a pedestrian oriented grid. Overall, the physical layout in a fused grid design determines the type of permitted activities and access that will work.

4.3.1.1.1 Street Design

Ten out of twelve respondents mentioned the advantages of street designs in a fused grid plan but stressed one disadvantage. The traffic gets diverted as a means to separate pedestrians from vehicles; however, R1 stated that an observer from the Saddleton community complained that it is difficult to navigate compared to the grid and the cul-de-sac pattern in
terms of way finding. In addition to that, R5 thinks there is a lot of resistance coming from the emergency unit and fire department because they are used to the more classic grid-like streets.

Traveling from point A to point B requires a longer route compared to the grid pattern of a traditional neighborhood development. Unlike the traditional grid, whose recurrence of four way intersections allow easy transition from one street to another, the fused grid has dead-end streets that prohibit vehicles from crossing onto another street. R2 stated that it's a slight inconvenience for people to drive out of their way in order to get to their destination, like in a conventional suburban development. In return, it would create more traffic on the surrounding avenues. In some parts of the fused grid street network pattern, vehicles can enter a neighborhood from one collector road and exit onto another collector road without any culs-de-sac that require turn around strategies. Contrasting that scenario, some parts of the fused grid street network pattern have local streets that dead end in an open space, thereby cutting off vehicular access. Another feature of the fused grid includes 3-way intersections throughout the plan, rather than 4-way intersections that are more prone to traffic collisions. R7 hopes that this feature will attract traffic engineers because the collision rate is six percent lower. In communities with other design systems, collector and arterial roads in the fused grid do not interfere with existing roads. R6 stated that, like in any other development, the roads have to be planned in a way that connects back to the major arterial.

One feature of the fused grid is the narrowing of roads to reduce the total pavement area. Three out of twelve respondents showed concerns regarding emergency vehicle access to the neighborhood when road widths are less than standard dimensions. Out of the three, one respondent mentioned 'road diet'. The respondent has a fundamental philosophy, stating that if more roads are built, people will continue to drive cars. This equates to the need for bigger and more roads. That particular respondent is prepared to accept tolerant congestion with the hope that congestion will encourage people to stop driving and start walking and biking. R5 is prepared to ‘starve’ the road'. One respondent believes that the roads have been designed
narrower to support more density, but that becomes a problem from a traffic engineering perspective.

Despite the fact that there are more roads in a fused grid, each road is much shorter when compared to the traditional grid or the cul-de-sac. The shorter the length of the road, the fewer the number of houses; therefore, "...you generally know everyone who lives on your street...that's probably a higher level of security as a result..." (R8). By knowing the people on your street, a sense of community is created.

4.3.1.1.2 Green and Open Space Infrastructure

In the City of Calgary, the ordinance requires that 10% of a development be reserved for public open space. The fused grid in this case is highly supported by the Parks department because not only does it surpass the minimum requirements, it is geographically located within walking distance in all directions (R3). From a green and open space perspective, a fused grid design offers more than just one neighborhood park (Grammenos 2008). In fact, in a typical layout of a land area consisting of a quarter mile, or 160 acres, like Calgary, there are at least four different open spaces. Some are conjoined between intersections of streets to create bigger parks, and some are conjoined at the dead end of a cul-de-sac. By having parks in a neighborhood, the value of any houses facing those parks is improved; therefore, both developers and the homeowner benefit from it.

The most unique features of a fused grid concept are the green connectors that offer a connected pedestrian route. One respondent was concerned that through these green connectors, it would invite strangers onto their streets, and possibly onto their property (R2). However, another respondent argued that Canada tends to offer quite an open community. "The strangers in our community are more apt to be welcomed than questioned" (R5).

4.3.1.2 Architecture/Built Space

R7 stated that in the artist renderings of the fused grid concept, only single homes are shown, therefore it sends the wrong signal to those looking at the plans, that the concept only
accommodates low density. In placement of single family homes, multi-level apartments or high-rise condos can be built to accommodate more people, as suggested by R7. According to R11, the "...fused grid should not minimize the number of destinations, such as local retailers, within walking and cycling distance of homes..." R4 stated that green spaces often adds value to adjacent houses in terms of real estate appraisals, therefore, the fused grid adds value to a lot of houses as there are so many parks in the fused grid design concept.

4.3.1.2.1 Developable Land

R6 stated that in a fused grid design, the majority of its land is developed, and in return, that will attract more developers. One of the reasons why developers switched to a Traditional Neighborhood Development in the beginning is the amount of units that are developed and the chance of selling more units. Thus, developers now look into the fused grid to save money or make more money by selling more units (R6). Respondents 1, 5 and 10 agreed that when developing land in a fused grid, walkability should be designed throughout the community because it is the selling feature.

4.3.1.2.2 Density

In a fused grid design, eight out of twelve respondents showed concerns about the amount of land that can be developed and how much density it can support. Three stated that the fused grid can only support a medium density while others argued that it can support high density. R2 in particular, stated that "It's not designed for a high density situation because obviously a bunch of dead end streets are not going to be a walkable solution for high density design". Contrary to that, R7 believes that "...a fused grid can handle any density when maintaining the continuity of the arterial and collector grid." R2 believes the fused grid design does not support high density and thereby makes the design not environmentally friendly.

The respondent argued that the network pattern of the fused grid should not affect the type of density. In fact, density is determined by the community and the municipality which is governed by zoning ordinances. R12 referred to density as "...a combination; partly the
governing body, partly the developers who are comfortable with developing what they think would sell, and partly the clients who actually value them and live or rent them."

4.3.1.2.3 Green Field Versus Retrofit

R7 highly believes that future fused grid projects are likely to be retrofitted rather than working from a green field slate. Certainly, implementation on a green field perspective would have a much higher level of success because it would contain a purer form of a fused grid (R8). By retrofitting, R7 refers to it as taking an existing street network, an existing built community with residential, retail and commercial uses, and implementing the fused grid design philosophy into the neighborhood.

4.3.2 Feasibility

4.3.2.1 Economics

R3 stated that the fused grid design would require some very expensive initial costs, but that the environmental benefits of getting more people out of their cars and having the opportunity to walk through the green connectors and parks is worth the investment. Neither of the two fused grid projects have completed construction, therefore, it's not possible to measure the return on investment. Three of the respondents showed major concerns over the economic investment and how it would work for them in the long term. R10 stated that developers need to find "...a balance between the environmental components and the economic components..." and sometimes "from a development perspective, the right thing to do is marry the two..."

4.3.2.2 Developer's Priority

Like all developers, the main priority deals with efficiency, which equates to profit and time. The Saddleton fused grid project in Calgary took five years from the time of concept proposal to first construction. To date, the construction is not 100% built. R3 stated that, because it's the first time that the fused grid is implemented in the city, it took one extra year to get approval from city council to make sure that it's operational and safe. The respondent also
mentioned that in the future, fused grid planning would be a four year process, reducing it by 20%.

4.3.2.3 Environmental Setting

All twelve respondents believe that the fused grid concept is a feasible design because it addresses many environmental issues. Foremost, it reduces traffic and offers alternative routes for pedestrians, creating a safer community.

In both case studies in Calgary and Stratford, the land is flat, making the incorporation of the fused grid plan easy to adapt. Two respondents mentioned that it would be interesting to see the fused grid in a different environmental setting, perhaps with more topography. They also mentioned that it could be challenging, but certainly not insurmountable.

4.3.2.4 Maintenance

According to R8, one of the biggest concerns of the fused grid involves maintaining the open spaces and the green connectors. “The Parks departments and Community Services departments are concerned with the process of maintaining the parks - the location to unload lawn equipments and the time needed to move from one park to another” (R8). Not only do the many open spaces in a fused grid design create an issue, the green connectors require continuous maintenance as it should be kept clean and safe to encourage walking and cycling. Respondents 5, 6, 7, 10 and 12 agreed that the concept of a fused grid works great, but the maintenance issue is one of the weaknesses from an economic perspective. Efficiency is lost.

4.3.3 Adaptation

Many of the respondents believe that the fused grid is nothing new. The ideas have been there for hundreds of years before the automobile existed. The fused grid is a combination of existing ideas with nice attributes (R2). Respondents 3 and 5 highly believe that the fused grid is just an improvement, a dendritic of the conventional suburban development street pattern. In other words, the fused grid is a sub feature; it's not the silver bullet that will solve all urban problems as it does not support very high density.
4.3.3.1 Governing Body

Adoption of the fused grid would require an approving governing body and a lot of legroom from developers (R1). Three respondents stated that any new development concept is always frowned upon, hence, the fused grid concept will struggle to gain support. One respondent in particular mentioned that the same issues apply in any new urbanist development, because it breaks away from the conventional suburban development. For example, the narrowing of roads in a fused grid design raises concerns from a municipality's perspective as they worry for the safety of their residents in emergency situations when fire trucks have difficulty turning on roads with smaller radii. A proposal for a new development will not be successful without going through a transportation engineer and all kinds of approvals. If the fused grid gets implemented in a denser part of a city, the same type of conflicts in other types of developments would occur. The governing body, essentially, has the final vote for any new development. The municipality, the consultants and the planners are resistant to change in the way neighborhoods are developed (R7). The old system has been working, therefore, why adopt a new model.

4.3.3.2 Spreading the Word

As of this date, the fused grid concept has been in existence for ten years since the initial concept was developed. The concept has not traveled far throughout the rest of the world for several reasons: 1) It has not been published widely enough; 2) When fused grid concepts are presented at conferences, attendees have showed concerns about land use density; 3) Practicability becomes the overall issue (R7). Four respondents do not believe the fused grid is a revolutionary new thing. It's more of a combination of existing ideas. Professionals, particularly developers, will have concerns over any new ideas because they are not reassured with profit prospects. However, one respondent believes that if the fused grid idea is advertised as anything but a new concept, people will buy into the idea more.
Essentially, the fused grid idea should be advertised as an integration of good ideas into a system that will create a more sustainable community. Three respondents mentioned that they also try to promote the fused grid concept through their work with clients because they see many social and environmental benefits. A respondent stated that the fused grid has the same concept as the smart growth and new urbanism model. They all try to design a more sustainable and healthy community that looks and feels good to live in (R4).

4.3.3.3 Alternatives

A respondent stated that developers are not offering the public more variety of neighborhood choices in terms of the types of developments such as the fused grid and traditional neighborhood development. "I think we're building what makes money for developers and the reason that people want it is they actually don't present it as an alternative" (R4). It's a 'take this or nothing', 'take it or leave it' kind of proposition. Therefore, the public takes it. The respondent believes more choices should be offered. Future fused grid projects would likely have to be in a hybrid form, similar to the case study in Stratford. Either because of environmental difficulties or a developer's willingness to develop a full fused grid, a hybrid seems to be a consensus from all parties involved (R7).

R1 stated that a willing group of developers is vital to the adoption of a fused grid. An approving authority or government body is also very important when it comes to accepting the fused grid. Respondents 1, 3, 5, 7 and 12 feel that the group of people who would have any kind of resistance towards the fused grid would come from the Parks department, due to the costs of maintenance and the Emergency and Fire department needing access to a particular home in a fused grid designed neighborhood.

The overarching principle of the fused grid concept is that it is a philosophy. It is not a cookie cutter design; therefore, future projects will most likely be a retrofit project rather than a green field project (R7).
4.4 Lessons Learned

Through the qualitative research method of data collection, the researcher was able to gather useful information because each interview questions generated more questions that allowed an in-depth discussion on the design and feasibility of the fused grid. At the end of each telephone interview, interviewees were asked if there was anything else they would like to share regarding the fused grid. All twelve respondents had something to share, and that opened more doors for discussions.

Several lessons were learned from the data collection. The first lesson learned involved the wide range of professionals that showed a great amount of interest in the fused grid, regardless of whether or not they were involved with the design or implementation process. Respondents were located in various parts of North America but still had a great amount of knowledge of the fused grid concept whether it was through their research or by being involved in the design and implementation process. The second lesson learned involved each respondents' attitude towards sustainable living. All twelve respondents mentioned that they believe it is the gateway to a new way of living and that the fused grid concept could create a trend in creating a sustainable and healthy lifestyle. The third lesson learned involved the accuracy of information given by respondents. There was one respondent who thought the fused grid project in Stratford had been completely constructed and that people are living in them. A few of the respondents have mentioned that they did not know the existence of either case study #1 in Calgary or case study #2 in Stratford. These responses showed that published literature has been very limited and that the news have not been widely transferred across the continent.

4.5 Summary

A fused grid design offers connectivity for pedestrians as some respondents argued that it is a design that favors walking and cycling. Theoretically, vehicle connections should work well when streets are laid out to merge with existing infrastructures. As stated, the fused grid is
pedestrian oriented, limiting vehicle access. Hypothetically, vehicles travel slower with shorter cul-de-sac roads and open spaces ending at the terminus.

The majority of the respondents stated that they would like to see the fused grid developed into a larger land mass to see repetition of patterns evolve. They would also like to see the evaluation of its predicted benefits to its built conditions such as the level of success with pedestrian connectivity and the safety aspects for the residents. Economic feasibility seems to be the main issue, as developers are not confident with this new street pattern, one that would impact many aspects including the physical realm and house values.

Respondents believe that future projects involving a fused grid would most likely be in the form of retrofitting rather than working off of a green field slate. In other words, principles of the fused grid such as pedestrian connection, open spaces and 3-way intersections would be applied into an existing community. Respondents also believe that the adoption of a fused grid would require an approving governing body and a strong willingness from the developers.
CHAPTER 5

CONCLUSIONS

5.1 Introduction

This thesis assessed the opinions of design and planning professionals and experts on the design and feasibility of the fused grid street network pattern. The research specifically concentrated on the design of the fused grid and how it affects the physical realm as well its feasibility and adaptation. This chapter discusses the findings as a result of open-ended, in-depth interviews regarding the perceptions of the design and feasibility of the fused grid street network pattern. It also discusses how those findings apply to the study's research questions:

1. How do fused grid designs affect the physical realm?
2. Is the fused grid a feasible design?
3. How adaptable is the fused grid in communities with other design systems?

This chapter also includes a discussion about the relevance of the study to landscape architecture. It concludes with recommendations for future studies and researches.

5.2 Evaluation and Summary of Themes

5.2.1 Design and Physical Realm

The designs of the fused grid impact the physical layout in a way that highly promotes walkability through the availability of green connectors separated from vehicular traffic. Results of this research illustrate that each house is in close proximity to the public open space, allowing residents the opportunities to engage in an open environment with families and neighbors. This encourages a sense of community, as everyone is likely to know each and every one of their neighbors. Because each street in a fused grid is designed shorter, as compared to a traditional neighborhood development grid or a conventional suburban development grid, there are fewer houses, therefore, it is easier for neighbors to keep an eye on each other's property.
The availability of open spaces and green connectors invite more people to walk and possibly enter someone else's street or even their property, which creates a concern for some respondents. However, those responses are personal opinions that deal with social connectivity. There are respondents who perceive that as a threat, whereas there are others who see it as an opportunity to connect and socialize.

A gridiron street pattern, as seen in many city centers, provide easy access for vehicles because of its direct and connected grid. In emergency situations, an EMS vehicle is accustomed to the traditional street design. At each four way intersection, it can either go straight or turn left or right to access another street. A T-intersection allows only two choice of travel as it put an end to the road and forces the vehicle to turn left or right. In a suburban neighborhood pattern, road patterns typically consist of loops and culs-de-sac. In a looping situation, the vehicle is physically forced to follow the same road and eventually back onto a minor collector road. In a cul-de-sac, or in other words, a lollipop situation, the vehicle is greeted by a dead end and is forced to turn around and go back out the same way that it came in. A look at Figure 5.1 shows the four different street pattern and intersections, showing the path of vehicles. The cul-de-sac, the Loop and the T-intersection are elements that can be seen in a fused grid plan.
In Saddleton, all three sides of the site have existing infrastructures, creating difficulty for the fused grid street network pattern to connect. Fortunately, that existing infrastructure had a roadway system that pivots with the idea of the fused grid (R3). Therefore, a basic collector system of roadways was already in existence, allowing the fused grid street design to fill in the gaps. Figure 5.2 shows the intersections of existing road infrastructures with the proposed fused grid road.
In the case of Stratford, a hybrid plan (See Figure 2.16) was chosen with a combination of the conventional suburban development grid and the fused grid. The hybrid was selected because the site is not appropriate for the type of land use that the fused grid suggested. The site is a relatively small community that did not require commerce, retail or commercial land use to take place. Therefore, a full fused grid plan was inappropriate in this context and a hybrid was chosen (R8).

Compared to other development patterns such as the Conventional Suburban Development and Traditional Neighborhood Development, the fused grid patterns work best when it's placed on a non-challenging topographical site. If a site has more topography, the street network patterns of a fused grid create an interesting physical realm. The location and size of green connectors could be impacted because of safety code regulations and ADA accessibility requirements. Position of green spaces perhaps could be more playful and allow
the designs of berms to take place throughout the parks. In return, this change also affects the
design of storm water management.

The built space in a fused grid design consist of residential homes, community facilities,
retail and commercial buildings. Residential homes could include single family, multi-family
housing, apartments and condos. The level of density can be supported depending on the type
of land uses that will take place. In Figure 5.3, a rendering shows that a high level of density can
be supported where each buildings can be designed as multi-storey such as in a city center.
Street patterns in a fused grid design do not prohibit the level of density, but rather,

![Figure 5.3 Fused Grid and Density Level (Grammenos 2008)](image)

Ideally, a fused grid design would be developed on a green field where there have not
been any development. In other words, there would not be any need to remodel or demolish
any existing structure prior to the construction of a fused grid. However, not all development
projects have the luxury of working off of a green field slate. Future projects are likely to
incorporate ideas and principles of a fused grid into an existing neighborhood rather than
building the entire fused grid into a 150 acre land. This form of retrofitting is likely to require the practice of street closures through diverters, and traffic bollards.

5.2.2 Feasibility

As mentioned previously, fused grid designs offer many opportunities and benefits from the perspectives of municipalities, developers and residents. However, these benefits also produce a few disadvantages. One respondent stated that there will be some very expensive initial costs such as installing storm water management utilities and changing the way that vehicles access a neighborhood. Further studies, particularly quantitative research, is necessary to assess the economic investment required from developers and the municipalities.

Every developer asks for efficiency on all development projects. Economically, the two case studies have not yielded any reliable results to learn from, but one respondent stated that with more parks, house values also rise, which in return, creates profit for the developer. Development efficiency depends on the net developable area as well as road infrastructure. The less land required to give up for new road infrastructure constructions, the more of it can be sold and built upon.

In terms of environmental feasibility, almost all respondents believe that the fused grid offers the opportunity for storm water management and the alternative mode of transportation - walking and cycling. This eventually could help to reduce air pollution because people are likely to drive less and walk and bike more. The fused grid optimizes the road pattern that serves a neighborhood by eliminating road length. Respondents hoped to see the fused grid in a development plan that is larger than a quarter mile. It would be interesting to see the repetition of patterns and the connectivity for pedestrians and cyclists to occur.

Each city have their own ordinance that requires a certain percentage of land use dedicated for parks. The many green spaces in a fused grid design raise concerns about exceeding that percentage. The area of a park is predetermined by geometry but not constrained by it (Grammenos 2008). In some layout of a fused grid, the green spaces are
contiguous where they subsume the intervening street width, which adds to their size. This not only exceed the percentage of land use dedicated to parks, it also require more time and money to maintain them. Results of the interview showed that maintenance of public open spaces and green spaces is the main concern regarding the fused grid concept. The benefit of having many public open spaces also comes with responsibilities and money for municipalities, which could impose more taxes on citizens who live in that particular neighborhood.

5.2.3 Adaptation

As with other types of developments, modifications are often times necessary to develop a solution. Overall, the fused grid comprises many ideas that worked with other types of developments and merged them together into one neighborhood. The fused grid is adaptable in other communities, depending on the environmental setting, and has the flexibility to adjust. An approving governing body is necessary to carry out the plan as well as a developer who is willing to set the trend for other neighborhoods.

Once the case study site in Calgary, Alberta is completely constructed, site observations and visitations become possible for people around the world. It may only take one project to hit ground in order for the concepts to travel and reach out to audience of all disciplines including design, planning, and development. Currently, the only way to learn of the fused grid concept is through secondary data such as the methodology used in this thesis. By having a physical built site, other studies such as assessing the real benefits of the fused grid is possible.

As mentioned in 5.2.1, future projects involving the fused grid are most likely to be retrofitted into an existing community. The differences between a fused grid design and a conventional suburban design (CSD) is much greater than that of a traditional neighborhood design (TND). The designs of the TND dramatically changed after it tries to move away from the auto-dependency, big box development, and suburban sprawl of the CSD. The designs of a fused grid takes a further step away from the CSD and the TND in an attempt to unite people
onto the same pedestrian path and away from vehicle traffic. This example can be shown in the hybrid plan as shown in Figure 2.16 for the case study in Stratford, Ontario.

Cities may not be fully equipped or ready to adopt 100% of the fused grid concept. They may incorporate partial ideas and principles into their existing neighborhood as an experiment before adopting a whole fused grid plan. In return, this raises questions of what percentage of fused grid ideas is actually considered a "full fused grid" plan. Would incorporating principles of fused grid into an existing neighborhood still be considered as fused grid or hybrid?

5.3 Discussion

Current land use and transportation models are not favorable for all modes of transportations (Benjamin 2007; Cervero 2005). This study explored the perceptions of different stakeholders on the design and feasibility of the fused grid street network pattern. Prior to the start of this research, it was hoped that the study would provide a clearer answer as to whether the designs of fused grid can be adapted in other communities. The collected data raised more questions than it provided answers. Does a fused grid neighborhood support families with young children and pets? What age group is appropriate? Is it geared towards young working adults, families in their forties or retired couples? Does a fused grid neighborhood support a certain socioeconomic class or is it a mixture?
Table 5.1 Transportation Network and Land Use Comparison (Source: Alexander 1997; Calthorpe 1993; Frank and Hawkins 2008; Gallion and Eisner 1963; Grammenos 2008; Grammenos and Gregory 2008; McNally and Kulkarni 1997)

<table>
<thead>
<tr>
<th></th>
<th>Conventional Suburban Development (CSD)</th>
<th>Traditional Neighborhood Development (TND)</th>
<th>Fused Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transportation network</strong></td>
<td>• circuitous</td>
<td>• interconnected grid like street patterns</td>
<td>• interconnected grid network of larger streets surrounding neighborhood</td>
</tr>
<tr>
<td></td>
<td>• meandering streets</td>
<td>• integrated pedestrian and cycle paths</td>
<td>• looping and dead end streets</td>
</tr>
<tr>
<td></td>
<td>• missing sidewalks</td>
<td>• narrow streets</td>
<td>• strong hierarchy of streets</td>
</tr>
<tr>
<td></td>
<td>• hierarchical street pattern</td>
<td>• on-street parking</td>
<td>• green spaces designed to improve pedestrian mobility</td>
</tr>
<tr>
<td></td>
<td>• limited access to arterials</td>
<td>• reduced speed limits</td>
<td>• easy transit accessibility</td>
</tr>
<tr>
<td></td>
<td>• wide streets without street parking</td>
<td>• many access to arterials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• predominantly auto based</td>
<td>• many modes of transportation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• easy transit accessibility</td>
<td></td>
</tr>
<tr>
<td><strong>Land use</strong></td>
<td>• segregated</td>
<td>• mixed land uses</td>
<td>• mixed land uses</td>
</tr>
<tr>
<td></td>
<td>• clustered land use</td>
<td>• close proximity of land uses</td>
<td>• close proximity of land uses</td>
</tr>
<tr>
<td></td>
<td>• access to a limited number of &quot;highly desirable&quot; land uses</td>
<td>• high residential densities</td>
<td>• high residential densities</td>
</tr>
<tr>
<td></td>
<td>• low residential densities</td>
<td>• access to parks</td>
<td>• access to parks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• recreation and distinct neighborhood centers</td>
<td>• recreation and distinct neighborhood centers</td>
</tr>
</tbody>
</table>

Table 5.1 is a compilation of the transportation network and the land use between a conventional suburban development, a traditional neighborhood development and a fused grid. When compared to the CSD, a fused grid design differ in terms of the interconnected grid and the green spaces that are in close proximity to residential land uses. When compared to a TND,
a fused grid design is very similar in terms of mixed land uses, high residential densities and availability of recreational facilities in each neighborhood center.

5.4 Relevance to the Profession of Landscape Architecture

Recent development projects involved the collaboration of planners, urban designers, architects and landscape architects. By means of streetscapes beautification, landscape architects are often time contracted to place the location of trees and shrubs. However, the profession of landscape architecture consists of more than just planting designs. A landscape architect can specialize in urban development and focus on the design, analysis and planning of outdoor spaces across a wide range of scale. The intention is to create places that are both meaningful and functional. Landscape architects have the educational training and skills to design everything from infrastructure elements, such as roadways, drainage systems, and parks, to cultural monuments, gardens for public and private housing units and urban spaces.

The fused grid study helps landscape architects learn of another form of street pattern that aimed to provide alternative modes of transportations and to accommodate population growth. If a landscape architect is involved in the early process of a development project, stormwater and drainage system designs could be integrated into the concept plan and bring to the table a set of skills that may be limited in other design disciplines. As a designer, an educator or a researcher, being informed of a street pattern that provide benefits that are both sustainable and healthy create opportunities to practice and promote the idea of pedestrian connectivity - a paradigm that landscape architects are an advocacy of.

The design implications that have emerged as a result of this study are valuable to landscape architects because the concept of connectivity, reducing dependency on automobiles, and creating a more sustainable and healthier neighborhood contribute to serving the public. Designers can provide different neighborhood settings by offering the public more than just the typical neighborhood housing on gridded patterns and culs-de-sac.
5.5 Future Research

This study addresses the perceptions of selected professionals regarding the fused grid model of suburban planning. Through the research process, the data spawned other questions that can be explored for future research. These areas of research include:

1. Systematically compare and evaluate the difference between Traditional Neighborhood Development (TND) and the Fused Grid model in terms of walkability and connectivity.

   This study can be evaluated by taking a closer look at the traditional neighborhood development design and the fused grid design for the same site location. Data could be measured in a similar comparison as shown in Table 2.2 to 2.8. Performing a quantitative study would likely yield more informative data than a qualitative study.

2. Assess the predicted benefits of the fused grid to the actual build out. There are several existing studies (Frank and Hawkins 2008; IBI Group 2007; Jin 2010) on the predicted benefits of the fused grid. However, the first adopted fused grid concept plan for the Saddleton Development in Calgary, Alberta have not been completely finished; therefore, those studies can only be backed up by theoretical intentions. When the Saddleton Development finishes, it would be interesting to assess the discrepancies from the predicted benefits to the actual benefits of the constructed fused grid.

3. Document the pedestrian connectivity for a green field fused grid versus a retrofit fused grid. The sites in Calgary, Alberta and Stratford, Ontario were green field areas making it less challenging to incorporate the fused grid design principles into the site plan. However, R7 mentioned that future fused grid projects would most likely be in the form of retrofit because there would be a lack of available land. It would be interesting to measure the pedestrian connectivity of a fused grid design on a green field and a fused grid design retrofitted into an existing neighborhood.

4. Analyze the costs of maintenance for public open spaces located in suburban developments and urban developments. In any chosen city, this study could look at
pocket parks, neighborhood parks, and community parks that are set within a suburban development and compare those set within an urban development. The determining factors for the maintenance of parks include the size, the number of plants such as trees and shrubs, the square footage of hardscapes as well as any water feature present in the park. Such quantitative information can be found in municipal records as it reveals the cost of maintaining small and big parks per square foot.

5. Document the economic feasibility of the fused grid concept as compared to other types of development. For the purpose of finding out what the advantages of the fused grid are, a closer look at the economic investment is necessary. Developers are essentially the main stakeholder group that make the types of development decisions, either conventional, traditional or fused grid. This quantitative study include determining factors such as the costs of road pavement, the costs of maintaining public open space, the costs of installing storm water management designs and the number of saleable architecture/built infrastructures.
APPENDIX A

IRB APPROVAL LETTER
UT Arlington
Informed Consent Document

PRINCIPAL INVESTIGATOR
Hong Mang, Masters Program in Landscape Architecture
Contact: hong.mang@mavs.uta.edu  Phone: 682-558-0537

FACULTY ADVISOR
Dr. Taner Ozdil, School of Architecture, Assistant Professor of Landscape Architecture
Contact: tozdil@uta.edu  Phone: 817-272-5089

TITLE OF PROJECT
Stakeholders' Perceptions on the Design and Feasibility of the Fused Grid Street Network Pattern

INTRODUCTION
You are being asked to participate in a research study about the fused grid. Your participation is voluntary. Refusal to participate or discontinuing your participation at any time will involve no penalty or loss of benefits to which you are otherwise entitled. Please ask questions if there is anything you do not understand.

PURPOSE
The purpose of this study is to assess the opinions of design and planning professionals and experts in order to systematically document the design and feasibility of the fused grid street network pattern. The study set out to answer the question: How do the designs of fused grid have an effect on the physical realm and is fused grid feasible?

DURATION
Participation in this study will last approximately 30-45 minutes.

NUMBER OF PARTICIPANTS
The number of anticipated participants in this research study is 30.

PROCEDURES
The procedures which will involve you as a research participant include answering a list of interview questions set forth by the researcher.

The interview will be audio recorded. After the interview, the tape will be transcribed, which means they will be typed exactly as they were recorded, word-for-word, by the researcher.

POSSIBLE BENEFITS

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This study will produce data that can be a contribution to the field and set a basis for future researches.

POSSIBLE RISKS/DISCOMFORTS
There are no perceived risks or discomforts for participating in this research study. Should you experience any discomfort please inform the researcher, you have the right to quit any study procedures at any time at no consequence.

COMPENSATION
No compensation will be offered for participation in this study.

ALTERNATIVE PROCEDURES
There are no alternative procedures offered for this study. However, you can elect not to participate in the study or quit at any time at no consequence.

VOLUNTARY PARTICIPATION
Participation in this research study is voluntary. You have the right to decline participation in any or all study procedures or quit at any time at no consequence.

CONFIDENTIALITY
Every attempt will be made to see that your study results are kept confidential. A copy of this signed consent form and all data collected including transcriptions/tapes from this study will be stored in Dr. Taner Ozdil's office at the University of Texas at Arlington School of Architecture building, room 417, for at least three (3) years after the end of this research. The results of this study may be published and/or presented at meetings without naming you as a participant. Additional research studies could evolve from the information you have provided, but your information will not be linked to you in anyway; it will be anonymous. Although your rights and privacy will be maintained, the Secretary of the Department of Health and Human Services, the UTA Institutional Review Board (IRB), and personnel particular to this research have access to the study records. Your records will be kept completely confidential according to current legal requirements. They will not be revealed unless required by law, or as noted above. The IRB at UTA has reviewed and approved this study and the information within this consent form. If in the unlikely event it becomes necessary for the Institutional Review Board to review your research records, the University of Texas at Arlington will protect the confidentiality of those records to the extent permitted by law.

CONTACT FOR QUESTIONS
Questions about this research study may be directed to the Researcher's advisor, Taner Ozdil at 817-272-5089 or tozdil@uta.edu. Any questions you may have about your rights as a research participant or a research-related injury may be directed to the Office of

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Research Administration; Regulatory Services at 817-272-2105 or regulatoryservices@uta.edu.

By continuing with this interview you are providing your implied consent to participate.

SIGNATURE OF INVESTIGATOR

DATE/TIME OF IMPLIED CONSENT

IRB Approval Date: Sep 19, 2012

IRB Expiration Date:
APPENDIX B

INTERVIEW QUESTIONS
Profile Questions

1. What is your professional background?
2. Were you involved with the designs of a fused grid? How many years were you involved?
3. Were you involved with the implementation of a fused grid? How many years were you involved?
4. How did you first learn of the fused grid?
5. Without being involved in the design or implementation process, what triggered your interests in the fused grid?

Interview Questions

1. How does the fused grid compare with other forms of development?
2. How does a fused grid work when used adjacent to other forms of development?
3. Is the fused grid a feasible form of design?

   Possible follow up questions: Is the fused grid economically feasible? Is it environmentally feasible? Is it design feasible?

4. What factors affect the adoption of a fused grid in other communities?
5. Is there anything else you would like to share regarding this topic?
6. Can you refer me to other designers/planners/developers that might be willing to participate in this study in regards to the fused grid?
APPENDIX C

SAMPLE EMAIL REQUESTING FOR INTERVIEW
Dear Mr./Mrs. John Doe:

I am completing my Masters of Landscape Architecture degree at the University of Texas at Arlington. My thesis topic is Stakeholders’ Perceptions on the Design and Feasibility of the Fused Grid Street Network Pattern. Your participation in this research project will help landscape architects, architects, planners, developers and any interesting parties to be informed of the fused grid. The reason that I am working on this particular topic is because I believe it is a topic that needs to be further explored and examined for possible implementation in the future.

I would like to request your participation in this research via a telephone interview. The interview will take approximately 30-45 minutes of your time.

Are you available to be interviewed at one of the following dates and times:

October xx, 2012 xx:xx am
October xx, 2012 xx:xx pm

Please call or email me if you have any questions. Thank you for your time and consideration. It is through this generous support of yours that this research can be successful.

Sincerely,

Hong A. Mang
Graduate Student
Program in Landscape Architecture
The University of Texas at Arlington

e-mail: hong.mang@mavs.uta.edu
phone: 682-558-0537
APPENDIX D

SAMPLE SCRIPT FOR INTERVIEW CONFIRMATION
Hello Mr./Mrs. John Doe:

    I am confirming our telephone interview on October xx, 2012 xx:xx am. Once again, thank you for agreeing to be a part of my thesis study.

    If there are any questions, feel free to contact me at my cell phone number (682) 558-0537 or email me at hong.mang@mavs.uta.edu.

    Regards,

    Hong Mang
    The University of Texas at Arlington
    Program in Landscape Architecture
REFERENCES


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National Housing Research Committee. (Fall 2002). New Residential Streets: Tranquil, Safe, Connected and Delightful.


BIOGRAPHICAL INFORMATION

Hong A. Mang was born in Vietnam. She was one of five siblings. She emigrated to the United States at the age of six and has resided in Fort Worth, Texas ever since. She became interested in interior design and architecture while attending a career fair in the sixth grade. After high school graduation, Miss Hong pursued her educational goals by attending the University of Texas at Arlington, where she received her Bachelor's of Science in Interior Design in 2009. Soon after, she enrolled into the Master of Landscape Architecture program to expand her scope of knowledge and professional opportunities.