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Shared Space in Today's World: Quantifying and Classifying the Range in Design

Parker Sorenson
University of Connecticut, parker.sorenson@uconn.edu

Shared Space in Today's World:
Quantifying and Classifying the Range in Design

Parker Dean Sorenson

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Shared Space in Today's World:
Quantifying and Classifying the Range in Design

Presented by

Parker Dean Sorenson, B.S.

Major Advisor: ____
Norman W. Garrick

Major Advisor: ____
Carol M. Atkinson-Palombo

Associate Advisor: ____
Nicholas E. Lownes

University of Connecticut

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3.0 Abstract

Shared space, a street design philosophy which aims to improve the mobility of non-motorized users by deemphasizing the priority given to automobiles, has received much international attention within the last decade. Today, shared spaces can be found across the world as planners and decision makers look to different street design schemes as a way of providing much-needed public space to urbanized populations. Despite their growing popularity, rigorous evaluations of how shared spaces operate are rather limited. Advocates of shared space argue that this design approach reduces vehicle speeds, reduces vehicle delay, reduces the potential severity of pedestrian-vehicle conflicts, and improves the mobility of non-motorized users in these design schemes, among other benefits. Critics argue that some users—especially those who are disabled—find shared space to be difficult to navigate. One particularly prominent gap in the literature is a framework to classify the now numerous flavors of shared space that have emerged around the world. This thesis presents a methodology to classify shared space according to 17 separate design elements and contextual variables such as traffic, land-use, and physical design. The classification scheme is operationalized with data from 132 shared spaces around the world, producing six distinct types of environment. The classification system illustrates the variety of ways in which shared space is being implemented around the world, paving the way for a more nuanced discussion of how different types of shared space function.

4.0 Introduction

Since the introduction of the *shared space* design philosophy in the 1980s by Hans Monderman in the Netherlands, *shared space* has seen implementation in many different contexts across the world (Hamilton-Baillie, 2008). At its core, *shared space* is a road design philosophy where the right-of-way is designed to be shared between different users – drivers, bikers, and pedestrians alike. The concept has been defined in various ways including "a public local street or intersection that is intended and designed to be used by pedestrians and vehicles in a consistently low-speed environment with no obvious physical segregation between various road users in order to create a sense of place, and facilitate multi-functions" (Karndacharuk et al., 2014a, p. 215). Over the last decade in particular, designers and officials have looked to *shared space* design as a way to overcome the decades long focus on automobile mobility, a focus which has frequently reduced pedestrian mobility even in the most historically walkable neighborhoods (Karndacharuk et al., 2014a, p. 190).

Today, however, there is an increased understanding amongst urban planners, transportation engineers, developers, and other decision makers that our roadways must serve our communities in many capacities. Indeed, the goal of improving traffic efficiency is one important function of our roadways, but this is not to say that this is the *only* function of our roads and streets (Project for Public Spaces, 2009). Increasingly, there is consensus amongst decision makers (e.g. UK Department for Transport) that focus on this aspect alone is detrimental to the communities these facilities are intended to serve (DfT 2007, p. 12). According to guidance by the Project for Public Spaces and Karndacharuk et al., streets also serve important roles by 1) providing access to adjacent properties and 2) serving as "place-makers", meaning they often

serve as social spaces, and frequently are the "image" of a community (Project for Public Spaces, 2009; Karndacharuk et al., 2014, p. 207).

Furthermore, there is continued recognition regarding the important role streets play within the public realm, as streets themselves often represent a significant proportion of public space available to residents. One such study by the UN Human Settlements Program found that streets typically consist anywhere between 15% and 35% of *all* land area in our city cores, and in Chicago, streets represent over 70% of all public open space within city limits (UN-Habitat, 2013, p. 51; Project for Public Spaces, n.d.).

As officials come to recognize the importance of our streets as a resource for providing needed public space, there has been an ongoing reevaluation of auto-centric street design schemes. Most recently, this has transpired with the proliferation of *shared space*, one of many design schemes that are intended to reverse the impacts of auto-centric designs. Designers are also increasingly looking for new solutions which adequately weighs the management of automobile traffic against the perceived "place-making" value.

Additionally, research has shown that previous design schemes which focused on segregation and control of different road users may not be the most efficient solution to handle vehicular traffic. Previous research by Wargo revealed that *shared spaces* often saw less vehicle delay when compared to models of traditional stop-controlled and signalized intersections, and adequately handled higher volume than would be expected at these traditional intersections built with similar geometry (Wargo, 2015, p. 45). In a world where urban population is expected to grow by 2.5 billion people by the year 2050, innovative solutions such as *shared space* deserve to be studied as a means to efficiently handle urban congestion (UN, 2014). Indeed, the research by Wargo shows that a *shared space* design philosophy can not only serve the community by

providing much-needed public space for pedestrians, but it can also manage traffic demands imposed on these facilities *better* than traditional designs which focus on the segregation and control of users (Wargo, 2015).

To understand the history behind what precipitated the shift to a *shared space* design philosophy, this thesis will first explore the long history of street design in the United States and abroad. This history is crucial to understanding the social construct of the automobile dominated streets that we are familiar with today. This thesis will discuss the historical evolution of the 'traditional' segregated user design approach in the early 20th Century and show how the proposed integrated road user concepts developed in the latter half of the 20th Century fit within this framework. This historical narrative will ultimately end with a review of the development of the integrated road user concept. In this section, the variety of similar design schemes will be introduced and will include a discussion as to the similarities and differences between the *shared space* concept evaluated in this paper.

After reviewing this history and introducing the *shared space* concept, this thesis will review the previous efforts completed to rate and classify these shared *space design* schemes (e.g. Shore & Uthayakumar, 2010). These rating systems rely entirely on design elements which indicate if a space can be considered more, or less, "shared". The shortcomings behind the previous efforts to establish a rating system will then be discussed. To address these shortcomings, this thesis utilizes a statistical clustering analysis using Ward's Method (Ward, 1963). The methodology for the proposed clustering analysis will be presented on in detail within this section.

Using a sample of 132 *shared spaces* to operationalize the data, the results of the statistical clustering analysis will then be presented. As will be seen, the methodology proposed

by this thesis will mark a departure from the previous point-based scoring system developed in the past, to one which proposes a simple typology of six different groups of *shared spaces*. To demonstrate how the proposed typology set may be utilized to classify new *shared spaces*, two simple case studies demonstrating the process is presented.

Finally, this thesis ends with a discussion regarding the potential impacts that the proposed share space typology may have to assist future research. While the *shared space* typology proposed in this thesis will be helpful in providing future work with a framework for which to analyze and discuss *shared space* design, it is noted that several areas of future work still exist. Primarily, this thesis recognizes the need to reconcile the differences between space design and context with differences in use to fully understand the impact shared space design has the mobility of all users in these environments.

5.0 Shared Space in a Historical Context

5.1 History of the Segregated Road User Design Approach

Throughout history, road design has constantly evolved to suit a variety of different purposes in each era (Karndacharuk et al., 2014). Indeed, up until the turn of the 20th century, streets were shared by much slower modes of transport; mostly, bicycles, trolleys, carriages, wagons, and horses (Baldwin, 1999). While technological advances in the 1800's saw the new introduction of some modes of transport, such as the streetcar and bicycle, the context of the street remained the same: slow mode transport meant that the entire street remained public space to be used by everyone alike (Norton, 2007, p. 331; McShane, 1994, p. 181). Sidewalks while present in the pre-automobile era, were merely built as a courtesy to pedestrians, a walkway raised by high curbs to keep them out of the dirt and mess that the central street often succumbed

to (Norton, 2007, p. 337). This certainly did not mean that pedestrians were prohibited from street at this time (Norton, 2007, p. 337). Indeed, they often were *expected* to use this space. Streetcar stops were frequently located in the center of the street, only accessible by walking across the street. Even though there remained no formal recognizable means of crossing until cities began experimenting with crosswalks in earnest in the 1920's, these pedestrians remained safe in the pre-automobile landscape (Norton, 2007, p. 340).

This all began to change however with the advent and introduction of the automobile around the turn of the century. Slowly, what was once viewed as a dangerous, recreational vehicle, became a common place means of transportation and way of commuting. *New York Times* articles and editorials of the time demonstrate the shift in perception towards automobiles. Before 1905, the *Times* viewed automobiles with skepticism and frequently referred to them as "devil wagons" while calling for a strict city-wide speed limit of 8 mph. As popularity in the automobile increased, the *Times* shifted their statements around 1905. Soon, the *Times* rhetoric slowly began to shift and coverage on fatalities began to "take a different tone … as [the *Times* transferred] blame to the victim" (McShane, 1994, p. 183).

As the number of automobiles within cities increased, the dynamic between those blaming pedestrians and those blaming the automobile drivers intensified. In what was truly a dramatic shift towards automobile use, cities across the US saw a noticeable change in the automobile traffic. This change was so sudden that by 1914 and 1915, every large American city reported "permanent twice-daily traffic jams" (McShane, 1994, p. 194). (Some scholars who study the idea of "disruptive technology" use the shift to automobiles in the early 20th Century as a classic example, e.g. Seba, 2016). Such dramatic growth in automobiles is demonstrated in Figure 1 which shows Easter Day Parade in New York City in 1900 and 1911.

1900 1911

Figure 1: Photographs showing Easter Day Parade in New York City demonstrating the rapid mode shift from house and buggy to automobiles.
Left: (Universal History Archive, 1900) *Right:* (Bain News Service, 1911) Adapted from: (Seba, 2016)

As automobile use increased, safety of pedestrians soon became an important and hotly debated issue. In New York City alone, pedestrian fatalities rose a staggering 310% in a 19 year period, from 232 fatalities in 1910 to 952 fatalities in 1929 (NYCDOT, 2010). Not surprisingly, the spike in deaths raised alarm, and US cities faced dramatic newspaper headlines throughout the beginning of the 20^{th} Century debating the cause and solution to these tragedies. Examples of this coverage is presented below in Figure 2.


APRIL'S HEAVY DEATH TOLL.

More Children Killed by Vehicles Than In Any Month Yet Recorded.

More children have been killed by vehicular traffic during April in this city than in any month on record, according to the report of the National Highways Protective Society, published yesterday. On Saturday night Jennie Osserman was run over by a grocer's wagon and Elsie d'Estere was run over by an auto.

In April in this city 5 persons were killed by trolley cars, 9 by autos, 3 by wagons, and 1 by a runaway horse. Thirteen of

(*New York Times* - May 2, 1910)


SAFETY EXPERTS CLASH ON SPEED

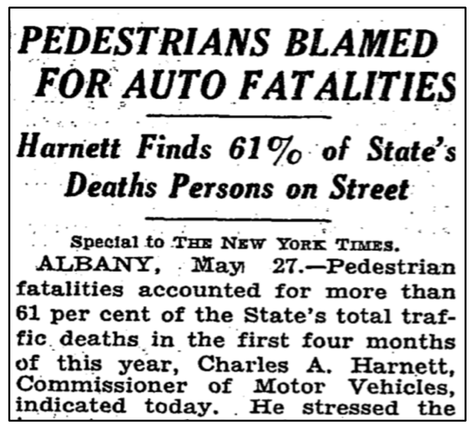
Auto Manufacturer, Predicting Safe 100-Miles-an-Hour Traffic, Urges Law Revision.

HE DRAWS SHARP REPLY

New York Insurance Expert Calls Idea "Outrageous" and Cites Rising Toll to Council.

(*New York Times* - October 1, 1929)

(*New York Times* - October 31, 1937)


PEDESTRIANS BLAMED FOR AUTO FATALITIES

Harnett Finds 61% of State's Deaths Persons on Street

Special to THE NEW YORK TIMES.
ALBANY, May 27.—Pedestrian fatalities accounted for more than 61 per cent of the State's total traffic deaths in the first four months of this year, Charles A. Harnett, Commissioner of Motor Vehicles, indicated today. He stressed the

(*New York Times* - May 28, 1938)

Figure 2: *New York Times* headlines of the era demonstrate the passionate debate between pedestrian and automobile viewpoints in the early 20th Century.
(Source: *New York Times*)

As city officials began to deal with this issue, debate arose as to how to best manage the public right-of-way (Norton, 2007). Most recognized that the rise in casualties on city streets due to conflicts were a problem, but consensus on a solution could not be found easily. Not surprisingly, some in these cities saw the car as an intruder that disrupted their way of life and caused significant safety concerns on the non-motorized (Norton, 2007). This faction often sought to limit the automobiles within these streets and preserve the status quo – the status quo

before traffic fatalities were much of an issue at all. Terms such as “joy rider” and “speed maniac” were invented to reinforce their feeling that these “reckless” drivers shouldn’t belong in the street (Norton, 2007, p. 342). Many in the country began to push for modern day speed limits with the such a law enacted at a statewide scale in Connecticut in 1901 which stated that no automobile may be driven faster than 11 MPH within the limits of any city (CT Historical Society, n.d.; Baldwin, 1999, p. 217). Such a statewide speed limit actually displaced local ordinances in Hartford which were set as low as 6 mph in the late 19^{th} century due to the fear of injury from *bicycles* (Baldwin, 1999, p. 216). Further support for a restraint on the operations of vehicles was further demonstrated in Cincinnati where more than ten percent of the City’s population signed a petition in 1923 requesting that governors be installed on vehicles to limit their operation to 25 mph (Norton, 2002, p. 317). Yet others suggested that automobiles be banned from the city core entirely (Ladd, 2008).

On the other side of the debate, however, were an increasing number of motorists, automobile clubs, and a strengthening automobile industry. This group recognized that in order to improve mobility for motorists, the dialogue needed to change. Taking a page out of the non-automobile playbook, they constructed, and used more successfully, terms such as “Jay Walker” and created campaigns to reinforce the idea that it was a motorists right to be in the street (Norton, 2007, p. 342). The attitude of this group is well represented by Miller McClintock, a consultant hired by the Los Angeles Traffic Commission in 1924, who stated “the old common law that every person, whether on foot or driving, has equal rights in all parts of the roadway must give way before the requirements of modern transportation” (Norton, 2008, p. 164). Thus, as “automobile owners, legislators, city officials, police & motorists worked together to extend

the customary and legal privileges" of motorists, the public often saw visible campaign material such as the pamphlets seen in Figure 3 (Baldwin, 1999, p. 214).

Figure 3: Cards distributed to pedestrians in Hartford, CT in 1921.
Source: "Boy Scouts and Kiwanis Club of Hartford Put on Anti-Jay Walking Campaign," *National Safety News* 3 [7 February 1921], 4. Courtesy of the National Safety Council (in Norton 2007, 346).

As time wore on, it became clear which solution would win out. Instead of limiting the operations of these new automobiles, regulations were imposed to control pedestrians and to keep them out of right-of-way except at defined locations "to protect the automobilists against the careless pedestrian" (Baldwin, 1999, p. 223). The recently-crafted terms of "Jay Walking" was codified into many locations as a finable offense, and the once shared street was stripped with crosswalks designating the legal areas for pedestrians to cross a street. Even in cases where traffic was entirely absent, pedestrians now found themselves being fined for crossing the street improperly (Baldwin, 199, p. 223).

In parallel to this debate, street design began to change as engineers designed the street to this fit within the new framework of automobile traffic. Slowly, cities began to remove many of the streetcar lines that once were commonly found in the center of the street and installed designated pedestrian crossings and formal traffic control devices. An example of how this change can be seen in Figure 4 which shows the changes seen at Herald Square in New York City over the course of a 22-year period.

1922 1944

Figure 4: Herald Square looking North on Broadway and 6th Avenue, New York City.
(New York Public Library, 1911)

Frequently, these physical design changes were also coupled with a reduction of pedestrian space, to meet the ever-increasing demand for space imposed by vehicles. Paradoxically, many scholars, such as William Whyte, noted that this reduction happened all while sidewalks saw considerably higher traffic rates with pedestrians than the street did with automobiles. Whyte found that in the 1980s (which likely saw less pedestrians than the earlier decades) foot traffic accounted for 78% of the traffic on Lexington Avenue in New York, while only comprising a mere 33% of the total right-of-way width (1988, p. 74). Nevertheless, these changes continued to take place, and sidewalk reductions, such as those demonstrated in Figure 5, became commonplace in cities across the United States.

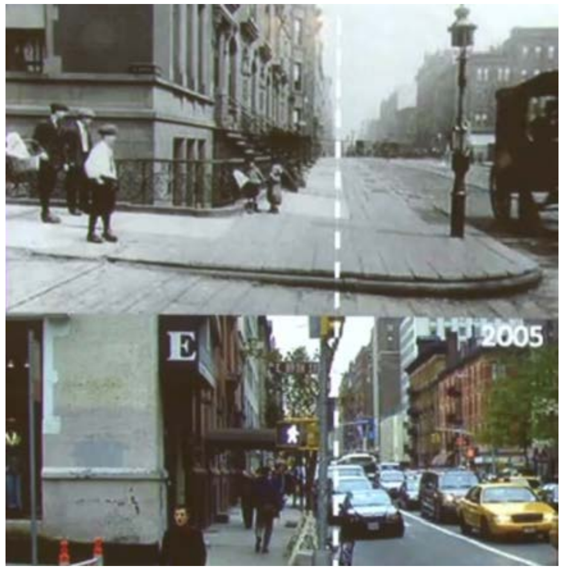


Figure 5: Comparative photos demonstrating the reduction in sidewalk width on 89th Street and Lexington in New York City to accommodate increased traffic volumes
(Donovan, 2005)

By the mid-20th century, the solution of a segregated road user design approach was thoroughly engrained in our culture, and many, if not most, of our streets conformed to this new context. Not surprisingly, it is in this environment which Jane Jacobs produced the revered *Death and Life of Great American Cities* and other scholars such as William Whyte were inspired to complete their work. These scholars were the first generation to live through the transformation of their beloved City, and recognized all that was lost since the introduction of this auto-dominated focus took hold of every streetscape in New York and, indeed, all American cities.

5.2 Introduction of an Engineered Integrated Road User Design Approach

Fed up with the negative impact the segregated design approach had on neighborhoods and unsatisfied by the safety improvements that the approach was meant to bring, transportation planners and engineers abroad began to reevaluate the appropriateness of the principle in many contexts (Hamilton-Baillie, 2008, p. 166). These designers were particularly interested in "prevent[ing] the decline in freedom of movement to children" due to the 'traditional' design

philosophy (Hamilton-Baillie, 2008, p. 166). In the Netherlands, this reevaluation began as the country experienced a substantial increase in traffic fatalities from 1,000 in 1950 to about 3,200 in 1972 (SWOV, 2016).

This effort to reevaluate the decades-old approach of segregating users by type was most notable in Europe, where planners began to experiment with a *shared space* design approach, one which integrated road users into the same physical space (Karndacharuk et al., 2014a). Transportation planners such as Joost Vahl began to experiment with this new philosophy with the introduction of the Woonerf design in the 1960s in the Netherlands (Hamilton-Baillie, 2008). Woonerfs, which loosely translates to 'yard for living', were designed in such a way to "reduce the impact of traffic on the qualities of social space" (Hamilton Baillie, 2008, p. 166), and aimed to subordinate vehicular traffic to pedestrians (Karndacharuk et al., 2014a, p. 198). By 1976, the term *woonerf* was formally recognized by the Dutch government, and was accepted as a standard method to design low speed residential roads (Hamilton Baillie, 2008, p. 167).

Figure 6: A typical *woonerf* in the Netherlands.
(Hines, 2015)

While the term *woonerf* caught on in the Netherlands and abroad, designers in Europe continued to search for ways to solve the many issues they identified with the segregated design approach. Most notably, these designers noted that these 'traditional' streets failed to meet the

"placemaking" goals within commercial centers, and many were frustrated with the level of control these design schemes placed on non-motorized users (Karndacharuk et al., 2014a). These designers pointed to a need to address non-motorized user mobility and safety in community centers as well, not just the neighborhood which *woonerfs* were constructed in. To accomplish this end, designers proposed that the *woonerf* regulations be transformed to allow similar spaces in shopping areas and city centers (Karndacharuk et al., 2014a, p. 198). Such transformation of the *woonerf* design concept led to the birth of the *winkelerf* and *stadserf* concepts which were simply shared streets designed in a similar manner as the *woonerf* with a focus on transforming commercial corridors (Karndacharuk, 2014a, p. 198).

Figure 7: A typical *winkelerf* in the Netherlands. Notice the commercial nature of the street. (Stephens, 2016)

As shared street design continued to evolve in the Netherlands, other governments in Europe began to develop their own shared street frameworks. Around the same time that the Netherlands introduced the *winkelerf* and *stadserf* concept to their commercial centers, Germany, Denmark, and Switzerland introduced the *rest and play* (*speilstrass*), *shared area*, and *begegnungszone* concepts respectfully (Karndacharuk et al., 2014a, p. 198). Modeled after the Dutch *woonerfs* of the previous decade, these behaved similar to *woonerfs* in that they aimed to improve the street environment for pedestrians and children playing by eliminating the distinction between the vehicle travel zone and the footpath in an effort to reduce the dominance

of vehicles (Karndacharuk et al., 2014a, p. 198). All three of these concepts were primarily developed in residential areas, similar to the Dutch *woonerf* designs that preceded them.

Figure 8: Examples of a *Rest and Play* area in Germany and a *Begegnungzone* in Switzerland.
Left: (Besold, 2016) *Right:* (Source: www.begugnugzonen.ch).

Meanwhile, in the United Kingdom, policy makers aimed to remedy an ugly history of jailing children for playing in streets in the early 20th Century by introducing new *home zone* regulations which allowed for the creation of similar residential streets (UK Parliament, 1860). *Home zones* were limited in the United Kingdom and existed in an informal manner until the adoption of formal *home zone* regulations in 2002 with the release of the *Home Zone: Design Guidelines* manual by the Institute of Highway Incorporated Engineers (Institute of Highway Incorporated Engineers, 2002). Similar to the *woonerf* concept before, *home zones* aimed to "remove the dominance of the car in residential streets" where "quality of life takes precedence over ease of traffic movement" (Institute of Highway Incorporated Engineers, 2002, p. 7). However, even while the objectives remain similar to those of the Dutch *woonerfs*, "Home Zones" differ from the *woonerf* concept in that they still incorporate some degree of vertical separation between users with curbs and similar features (Karndacharuk et al., 2014a, p. 199).

Figure 9: The Lady Bay Home Zone in the United Kingdom
(Lally, 2010)

Ultimately, as these schemes saw success and more recognition in Europe, designers outside of the continent began to recognize the benefits of integrated design schemes and began implementing them in their own country. The 1980's saw the spread of this integration design concept with the introduction of the shared street concept internationally. The *shared street* concept was developed to primarily serve quiet, residential settings, and maintained a focus on deprioritizing the dominance of the automobile through a variety of techniques. In this scheme, complete integration of vehicle traffic into the residential space wasn't a primary goal, and frequently safe zones for pedestrians, such as sidewalks, were incorporated throughout the entirety of the space (Karnadacharuk et al., 2014a, p. 198). *Shared streets* often manifested themselves in designs such as a *chicane*, such as the quiet residential street in Philadelphia depicted in Figure 10 (Karnadacharuk et al., 2014a).

Figure 10: A chicane on a quiet residential street in Philadelphia, PA
(NACTO, 2011)

The *shared zone*, the final term for a *woonerf* concept for residential streets, was developed in Australia and New Zealand in the 1980's (Karndacharuk et al., 2014a). The *shared zone* was designed in the same way as a *woonerf*, and featured the same goals to increase safety of pedestrians and bicyclists through the integration of vehicles into the residential space (Karndacharuk et al., 2014a). These zones feature a low 10 km/hr speed limit, and pedestrians legally have the right-of-way at all times (Transport for NSW, 2012).

Figure 11: An example of a legal *shared zone* on Redfern Lane in Sydney Australia.
(Source: Google Maps Streetview)

While the last development, *shared space*, will be discussed in further detail in the following section, Table 1 presents a summary of all integrated street concepts and terminology discussed in this thesis.

Table 1: Listing of different names of various integrated road user design approaches. (Karndacharuk et al., 2014a, p. 198; Sauer, 2016, p. 3).

Terminology	**Jurisdiction**	**Decade Introduced**	**Adjacent Land Use**
Woonerf (Shared Street)	The Netherlands	1960s	Residential
Winkelerf & *Stadserf*	The Netherlands	1970s	Activity Centers
Rest and Play / *Speilstrasse* (Shared Area)	Denmark and Germany	1970s	Various, Predominately Residential
Begegnungszone (Encounter Zone)	Switzerland	1970s	Various, Predominately Residential
Home Zone	UK	1970s	Residential
Shared Street	International	1980s	Residential
Shared Zone	Australia and NZ	1980s	Various
Shared Space	International	1980s	Various, Predominately Activity Centers

5.3 Development of the Shared Space Design Concept

The concept of *shared space* thus came only after decades of development with previous concepts using a similar integrated approach in different global regions and different contexts. While the Netherlands had experience implementing the *winkelerf* and *stadserf* concept in their activity centers in the 1970s, these concepts still differed drastically from that of *shared space* in traffic was typically limited within these areas (Moody & Melia, 2012). As developed by practitioners, such as Hamilton-Baillie in the United Kingdom, the concept of *shared space* doesn't necessitate on the reduction of traffic (Moody & Melia, 2012). This allows for such designs to be considered for many more facilities, and not on the precondition that traffic be nearly eliminated from the street being evaluated.

Conceptualized in the 1980's by Dutch engineer Hans Monderman amid growing concerns over child pedestrian casualties (Hamilton-Baillie, 2008), *shared space* aims to improve safety and neighborhood vibrancy by shifting priority of urban spaces to people rather than automobiles (Karndacharuk et al., 2014a, p. 197). According to Reid et al., the *shared space* concept is ultimately a solution to meet seven objectives described below in Table 2.

Table 2: The seven objects of *shared space* (Reid et al., 2009)

1) Inspire Economic Regeneration
2) Increase Pedestrian Mobility
3) Increase Sense of Place
4) Reduce Vehicle Dominance
5) Increase Pedestrian Activity
6) Improve Safety
7) Promote an Inclusive Design

Where others saw a solution in further segregating uses and expanding roadway capacity, Monderman pushed for increased access for pedestrians, and a removal of formal traffic controls. Perhaps paradoxically, Monderman noticed that the removal of such controls often improved both *safety* and *traffic efficiency* by eliminating the inherent delay that is associated with formal traffic controls (Noordelijke Hogeschool Leeuwarden, 2007). Traffic benefited from the elimination of conditions which required full stops (such as red lights, and stop signs), and pedestrians benefitted from lower speeds of operating traffic (Noordelijke Hogeschool Leeuwarden, 2007). The result was traffic which operated slowly, but consistently (Noordelijke Hogeschool Leeuwarden, 2007). Such a phenomenon was perhaps the reason why Wargo found that *shared space* measured an intersection delay of up to 97% *lower* than those predicted for a traditional all-way stop, or a traditional roundabout (Wargo, 2015).

A key feature to Monderman's *shared space* concept was the pioneering of a minimalist solution which removed all "clutter" from the street (Gillies, 2009). Also dubbed 'naked streets', and 'curbless streets', Monderman's *shared spaces* were often noted for the lack of curbs, demarcation in materials, and the way in which they prompted users of different modes to interact during crossing (Gillies, 2009). Instead, these spaces placed heavy emphasis on those items which would make these spaces feel controlled by pedestrians – properly scaled lamp

posts, benches, greenery, art, and spaces to congregate (Shore & Uthayakumar, 2010). An example of design elements included in such *shared spaces* is presented below in Figure 12.

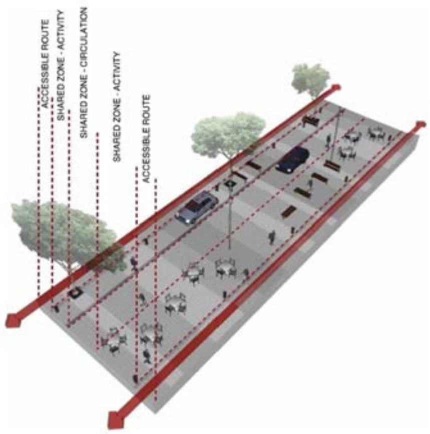


Figure 12: Typical design elements found in *shared space*
(Karndacharuk et al., 2014a, p. 210)

Monderman, once the Head of Road Safety for Friesland in the Netherlands, became particularly active in the early 1990's in the region, located in the northern part of the Netherlands (Hamiliton-Baillie, 2008, p. 169). During this time, Monderman's concepts began to make a name for themselves as his solutions included removing "every standard road sign, signal, and road marking" in the entire village of Makkinga and transforming the main street of Wolvega through the removal of a busy traffic signal and replacing the intersection with an informal town square while still allowing traffic to access the area (Hamiliton-Baillie, 2008, p. 169). Amazingly, these first projects led to a dramatic reduction in collisions, and reductions of traffic speeds in the vicinity of 40 percent (Hamiliton-Baillie, 2008, p. 168).

Figure 13: *Shared space* design in the center of Wolvega, Netherlands
(Source: Google Maps Streetview)

By the mid-2000's Monderman, who led the EU project on *shared space* between 2004 and 2008, oversaw the implementation of a *shared space* ideology in several heavier trafficked areas (Fryslan Province, 2008). This included the conversion of a main street which carried between 8,500 and 12,000 vehicles per day in Haren to a *shared space* design, and the conversion of a busy signal in Drachten which handles some 22,000 vehicles per day (Hamilton-Baillie, 2008). Here, the efficiency and safety improvements stand out. Instead of heavy delays caused by frequent pedestrian crossings, the delay experienced by both vehicles and pedestrians alike were reduced. In Drachten, delays for buses, which previously had a priority transponder for the old signalized intersection, dropped by over 50% after the implementation of the *shared space* design (Noordelijke Hogeschool Leeuwarden, 2007). Since it was now easier and encouraged for pedestrians to cross along the length of the space instead of one single crosswalk, delays dropped for vehicles as pedestrians no longer bunched to cross at these limited locations.

Figure 14: Laweiplein *shared space* in Drachten, Netherlands
(Mihaly, 2014)

As these spaces continue to be implemented throughout the world, there continues to be growing interest into the safety, operations, and benefits of these spaces. In before-and-after video analysis by Karndacharuk et al. of a *shared space* scheme on Elliot Street in Auckland, New Zealand, the author found that the not only has vehicle speeds dropped, pedestrian users were found to have greater priority over vehicle users (Karndacharuk et al., 2014b, p. 7). Futhermore, Karndacharuk et al. found a strong correlation between the number of interactions between users and speed. As the number of observed user interactions between vehicles and pedestrians increased in an urban setting, the observed vehicle speeds dropped at an exponential rate; suggesting that high levels of interactions increase the safety of a space through a dramatic reduction in speed (Karndacharuk et al., 2014b, p. 8).

Furthermore, research has also focused on pedestrian "dwell time" as an indicator to understand the impact in urban vitality these schemes have on the city in what seems to be the measured equivalent of Jane Jacob's "eye's on the street" philosophy (Jacobs, 1961). Research by Kaparias et al., the study authors found that a new shared street design on Exhibition Road in London, UK found that "pedestrians show great comfort and confidence… [and] also appear to be more at ease when crossing" (Kaparias et al., 2016, p. 26).

While there has been a recognition that the benefits seen by Monderman's *shared space* schemes have been generally positive many others approach the design scheme with skepticism. Several surveys, including those undertaken by Moody & Melia, Holmes, and Kaparias et al. indicate that users can be cautious and wary of such design schemes in certain contexts (Moody & Melia, 2012; Holmes, 2015; Kaparias et al., 2012). As will be discussed in further detail, particular criticism is prevalent within the blind community in the United Kingdom, which views vertical separation as critical to providing their community the indicators they need to navigate urban space (Moody & Melia, 2012). Finally, these critics often point to the disconnect between design and usage the needs to be addressed by *shared space* advocates, with Moody & Melia questioning "if a shared space design fails to improve pedestrian movement should it still be considered a shared space?" (Moody & Melia, 2012, p. 1).

6.0 Defining the Range of Shared Space Design

6.1 Developments towards a Shared Space Classification Scheme

As more and more *shared space* concepts have been implemented throughout the world, it is clear that no two *shared spaces* are exactly alike. *Shared spaces* are often designed specific to the context they serve, and can vary drastically from concept to concept. Specifically, the design elements of each of these spaces can differ. Some spaces may be curbless while others have traditional 6-inch curbs. Some may include the use of crosswalks or more subtle "courtesy crossings" while others may not include any indication of a crossing at all. Other elements that may differ between designs include the use of texturized pavement, use of bollards, presence of parking, overall width, presence of a pedestrian "safe zone", surface demarcation between users,

presence of free standing lamps, presence of greenery and landscaping, presence of art, and presence of seating among other indicators.

This variety in design is likely a consequence of the fact that these spaces are highly specific to each location and no formal design guideline exists for *shared space* in the same way that formal guidance exists for streets designed under a more traditional philosophy (Wargo, 2015). Indeed, Wargo notes that such a "manual" for *shared space* may not even be desired as the introduction of such standards could, in fact, be harmful for the purpose these designs are intended to serve (Wargo, 2015). Instead, these spaces rely on the fact that each of these spaces is driven heavily by the individual context within which they exist (Wargo, 2015).

Furthermore, to date there has been limited work defining the range of design of *shared space*. Wargo addresses this issue by assigning a subjective "sharedness" measure between each of the spaces included in his study, but a defined scale remains elusive (Wargo 2015). Others, such as the UK Department of Transport, recognize that *shared space* streets may be either "more shared" or "least shared", but don't define what might make one space more shared over another (DfT, 2011, p. 12). Shore & Uthayakumar, recognize the benefit of having a definitive way to rate a *shared space* based on design characteristics, and propose a scoring system to rank these spaces on several criteria (Shore & Uthayakumar, 2010, p. 2.6). These authors, however, recognize the shortcoming behind such a scoring system in that the overall score of a *shared space* is "heavily dependent on the variables included in the questionnaire and the relative weights assigned to them" (Shore & Uthayakumar, 2010, p. 2.6).

The lack of a classification or rating scheme remains problematic for the study and implementation of *shared space* design and variance in design between *shared space* concepts means it's difficult to apply conclusions from one *shared space* to others. Moody & Melia raise

this issue in their criticism by pointing out that contextual differences could account for the differences found in their results (Moody & Melia, 2012). Other work, such as an informal survey by Lord Holmes of Richmond conducted in early 2015, Holmes finds that “people’s experiences of shared spaces are overwhelmingly negative”, and one such pedestrian respondent indicated that her experience was “lethally dangerous” (Holmes, 2015, p. 4). Holmes’ survey did not collect information regarding the design of the *shared space* that was described as “lethally dangerous” however, so it is hard to know exactly what characteristics could be changed to from the design of concern (Holmes 2015). While such user feedback is typically helpful for engineers to improve designs in the future, the lack of a defined *shared space* classification system perhaps limits the conclusions that may be drawn from such a sample besides to say that ‘some *shared spaces*’ are received negatively.

Furthermore, research assessing user perceptions of a *shared space* scheme on Widemarsh Street in Hereford, UK from the blind, partially sighted, elderly, and handicapped communities found that a number of users maintained concerns with the design of this *shared space* scheme with regards to the curb consistency and particular interactions with vehicles (Hammond and Musselwhite, p. 2013, 90). The findings in this survey, however, were generally more positive than that of the Holmes study, demonstrating the need to understand the causes of these differing results more comprehensively.

As discussed above, Shore & Uthayakumar developed a rating system for which to rank *shared space* designs on several physical design traits (2010). While Shore & Uthayakumar recognized the shortcomings of their survey, it represents an important first step to understand the operations of a *shared space* in context of how it is designed (2010). The survey used for their classification scheme is presented below in Figure 15.

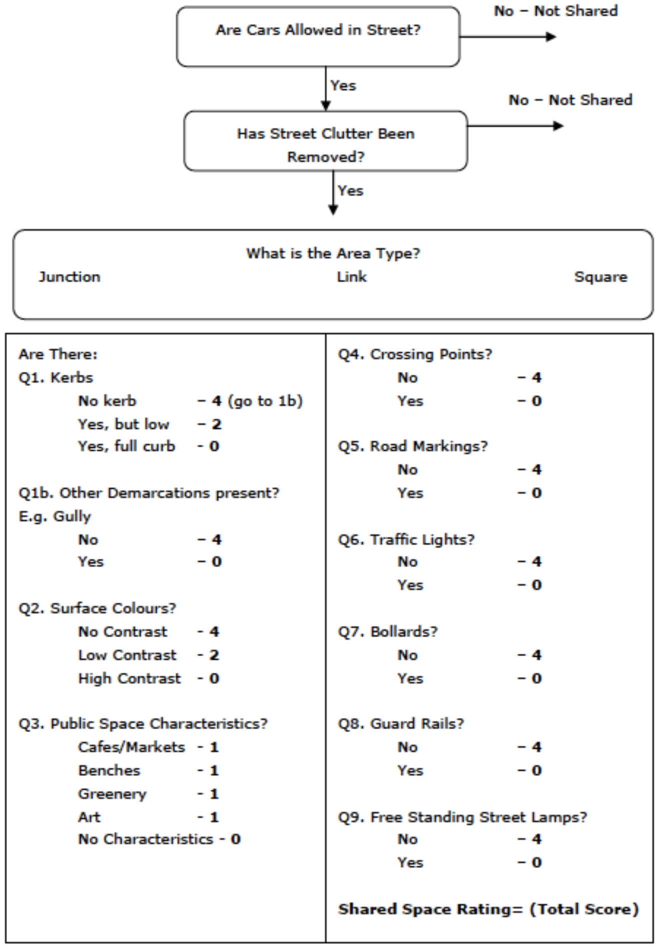


Figure 15: The *Shared Space* Rating Scheme developed by Shore & Uthayakumar (2010, p. 2.6)

As can be seen through the survey questions in Figure 15, this classification scheme maintains a focus on the assessment of static infrastructure design, rather than analyzing observed behavior of users in these spaces. Such a survey was developed in order to simplify the understanding of *shared spaces* and to provide a quick, simplified ranking of these spaces using a simple ranking scheme. Shore & Uthayakumar recognize the fact that the design of concepts affects user behavior outcomes to a varying degree depending on the context in which these spaces are built (2010).

6.2 Methodology to Review Shared Space Schemes

In order to better understand the current status and range of *shared space* design, several characteristics were collected for a sample of 132 *shared spaces* worldwide. These 15 characteristics, which focused on the physical attributes of these spaces, were found by virtually surveying these spaces through Google Maps Street View. Measured values, such as Width of Traveled Way were estimated using the measurement tool within Google Maps when applicable. The characteristics collected in this survey formed the basis of the classification work discussed later in this section. These are presented below.

Table 3: Input Variables used for Classification Scheme. See the Section 11.0 Appendix A for examples of each characteristic. Values representing spaces exhibiting 'more sharedness' are given a higher numerical code.

Characteristic	**Possible Values**	**Numeric Code**
Curbs	No Curb	8
	Drainage Gully	6
	Yes, Low Curb	4
	Yes, Full Curb	0
Pedestrian "Safe Zones"	No	6
	Yes, Sporadic	2
	Yes, Entirety of Shared Space	0
Surface Demarcation	No Contrast	4
	Low Contrast, Materials Based	2
	High Contrast, Painted Lines	0
Pedestrian Crossing Points	None	4
	Yes, Few Informal Material Crossing	2
	Yes, Painted	0
Road Signs	None	4
	Yes, Minimal	2
	Yes	0
Fences & Other Ped. Obstructions	None	3
	Yes, Few Ped Obstructions Present	1
	Yes, Fences and Guard Rails Present	0
Free Standing Lamps	No	2
	Yes, Ped. Scale	1
	Yes, Full Streetlights	0
Outdoor Cafes or Markets	Yes	1
	No	0
Seating	Yes	1
	No	0
Greenery	Yes	1
	No	0
Art / Fountains / Monuments	Yes	1
	No	0
Public Square / Activity Center	Yes	1
	No	0
Texturized Driving Surface	Yes	1
	No	0
Parking	Yes	1
	No	0
Width of Travelled Ways	[ft]	-

Table 3 consists of several of the characteristics utilized for the previous classification scheme developed by Shore & Uthayakumar, with the addition of several others including 1) pedestrian "safe zones", 2) presence of road signs, 3) texturized driving surface, 4) the presence of parking, and 5) width of the travelled driving surface (2010). Many other characteristics

presented in the previous study, however, were expanded to account for multiple different design solutions that exist within a continuum of possible values. For example, within the characteristic of "Pedestrian Crossing Points" a value of "Few Informal Material Crossings" was added to account for the fact that many designs included more subtle "courtesy crossings" that were delineated with minor changes to the surface color.

It is also important to point out that all characteristics, with the exception of the width variable, are ordinal, not numeric, variables. For example, while the "curb" variable includes numeric codes between 0 and 8, there is no meaning between the distance between these values. The difference between a 'no curb' value of 8 and a 'drainage gully' value of 6 is not necessarily smaller than the difference between a 'low curb' value of 4 and a 'full curb' value of 0. However, defining the data as ordinal is critical because it is clear that the 'no curb' response is closer to 'low curb' value than to 'full curb' response. During statistical analysis, these variables were defined as ordinal, which removed any meaning of distance between these values during the future classification step of this process.

In addition to these characteristics, several additional data points were collected to define the context for which these spaces are found. These points were collected to ultimately provide contextual information regarding the surrounding land use intensity where these *shared spaces* are located and to provide information regarding the role these spaces play in the greater transportation network. The Urban Transect scale was used to provide a subjective description of the adjacent land use intensity, and a graphic showing the definition of this scale is presented in Section 12.0 Appendix B. The scale ranges from a value of T1, which represents the most rural space, to a value of T6, which represents the densest of city cores (Center for Applied Transect Studies, n.d.).

Network connectivity was measured based on a subjective classification of the location of the *shared space* in relation to the surrounding transportation network and the importance that each facility plays for each. Since international classification of transportation facilities varies, this research relied on a self-developed network connectivity scale ranging from "Local", which represents facilities which provide access to local properties, to "Regional", which represents facilities which play a larger role in the transportation network beyond the limits of the neighborhood and the municipality. A visual scale of this ranking with examples of how these facilities fit into each category is provided in Section 13.0 Appendix C.

After collection of this data using the methods described, it was determined that the use of a Hierarchical Classification scheme would be evaluated using SPSS software utilizing Ward's Method. After preliminary analysis, a solution finding six groups was sought, as this was recognized as a natural number of clusters for the data, based on visual analysis of the results. ANOVA was run on all characteristic variables to test the significance of each between groups and those values that didn't meet the significance level of $\propto$=0.05 were not considered. A full table of result in the statistical analysis, including the results from these insignificant characteristics, is provided in Section 15.0 Appendix E.

Table 4: Significance results for each characteristic. Characteristics which are shaded were not used to define each group.

Variable	ANOVA Sig.
Curbs	0.000
Ped Safe Zones	0.000
Ped Crossings	0.000
Road Signs	0.000
Cafes	0.002
Surface Demarcation	0.020
Texturized Driving Surface	0.024
Free Standing Lamps	0.049
Greenery	0.059
Parking	0.143
Fences	0.185
Seating	0.294
Public Square	0.421
Art	0.928

It was found that the characteristics *Greenery, Parking, Fences, Benches, Public Square,* and *Art* were insignificant between groups. The remaining characteristics *Curbs, Pedestrian Safe Zones, Pedestrian Crossings, Road Signs, Cafes, Surface Demarcation, Texturized Driving Surface, and Free Standing Lamps*, were then arranged in the order of significance found. Descriptive statistics were then found for each group, which was used to subjectively rank the resultant SPSS categories from “most shared” (6) to “least shared” (1). These results are presented in the following section, as well as a listing of the complete results in Section 14.0 Appendix D.

7.0 Results

7.1 Presentation of the Shared Space Schemes Selected and the Shared Space Typology

As discussed in the previous section, 132 *shared spaces* locations worldwide were evaluated for this thesis. These *shared spaces* were found in a variety of literature and online resources, and the little effort to pre-screen these spaces was undertaken. The only requirement for inclusion in the study was that it had to meet the definition of *shared space*, which meant that vehicle traffic had to be permitted in the space and the space had to differ from traditional infrastructure in either its design (e.g. elements discussed in Table 3), or its use (e.g. bike corrals in middle of street such as with Kensington High Street, London).

A summary of the location of the spaces studied for this project is presented below in Table 5. Here it is noted that the United States, the United Kingdom, and the Netherlands represent the majority of the spaces studied in the project, however the vast majority of such spaces remain in Europe.

Table 5: A summary of the spaces studied for this project broken down by country and region

Region	Country	n	n (region)
Asia	Japan	4	4
Europe	Austria	1	80
	Belgium	2	
	Denmark	9	
	France	2	
	Germany	3	
	Hungary	1	
	Italy	1	
	Netherlands	21	
	Poland	2	
	Portugal	2	
	Spain	6	
	Sweden	1	
	Switzerland	3	
	UK	26	
North America	Canada	3	34
	Mexico	1	
	USA	30	
Oceania	Australia	2	10
	New Zealand	8	
South America	Argentina	2	4
	Brazil	1	
	Chile	1	
	TOTAL	**132**	

After the evaluation of these 132 *shared spaces* utilizing the method described in the previous section, the resulting categories were then ranked based on their statistical characteristics. The result is shown in Table 6.

Table 6: A review of the statistical characteristics of each *shared space* group. These were subjectively ordered such that Group 6 represents the most *shared spaces* while Group 1 represents the least shared.

GROUP	Curbs	Ped Safe Zones	Ped Crossing	Road Signs	Cafes	Surface Demarcation	Texturized Driving Surface	Free Standing Lamps
Values	*[0,4,6,8]*	*[0,2,6]*	*[0,2,4]*	*[0,2,4]*	*[0,1]*	*[0,2,4]*	*[0,1]*	*[0,1,2]*
6	7.44 ± 1.34	6.00 ± 0.00	3.61 ± 1.04	3.33 ± 1.37	0.56 ± 0.51	2.94 ± 1.00	0.78 ± 0.43	1.28 ± 0.58
5	8.00 ± 0.00	1.38 ± 1.20	4.00 ± 0.00	4.00 ± 0.00	0.94 ± 0.25	2.63 ± 0.96	1.00 ± 0.00	0.94 ± 0.68
4	8.00 ± 0.00	0.57 ± 0.93	3.81 ± 0.60	1.62 ± 0.81	0.67 ± 0.48	2.29 ± 0.96	0.90 ± 0.30	0.71 ± 0.56
3	4.50 ± 0.89	0.94 ± 1.12	3.75 ± 0.68	2.88 ± 1.03	0.25 ± 0.45	1.94 ± 0.93	0.69 ± 0.47	0.75 ± 0.68
2	5.20 ± 1.79	0.00 ± 0.00	0.00 ± 0.00	2.20 ± 0.45	0.80 ± 0.45	1.60 ± 0.89	0.40 ± 0.55	0.80 ± 0.84
1	0.00 ± 0.00	0.00 ± 0.00	2.67 ± 1.63	1.33 ± 1.63	0.67 ± 0.52	1.33 ± 1.03	0.67 ± 0.52	0.50 ± 0.55
Total	6.44 ± 2.44	1.91 ± 2.37	3.48 ± 1.21	2.72 ± 1.35	0.62 ± 0.49	2.32 ± 1.05	0.80 ± 0.40	0.88 ± 0.66

As can be seen from Table 6, the defining characteristic of each category varies drastically between each group. This can be seen by examining the differing relative standard deviation in each case. For example, Group 1 includes spaces that only feature no pedestrian

"safe zones" (shown with $\sigma = \pm 0$). Other characteristics for Group 1 suggest that Group 1 spaces generally feature no curb separation, but the standard deviation shows that this is not the "rule". A descriptive summary of each group is presented below in Table 7.

Table 7: Written description of each group classified for this thesis

GROUP	DESCRIPTION
6	These spaces are characterized **primarily by their lack of pedestrian "safe zones".** They may have some degree of vertical separation with a drainage gully, but **don't feature any sort of curb full height or otherwise**. Informal **crossings for pedestrians may exist** through the use of materials, and the use of **standard pavement materials may be used** for the driving surface. The presence of cafes or activity generators is not necessary for this group.
5	These spaces are characterized **primarily by the lack of curbing**, **no noticeable designated pedestrian crossing** location, **no traditional road signs**, and **a texturized driving surface**. However, these spaces **typically incorporate a pedestrian "safe zones",** either in a portion of the streetscape or throughout its entirety. Additionally, these spaces often have **pedestrian scale lighting** and may include delineation of users through the use of materials. These spaces frequently are noted by the presence of outdoor cafes or other commercial activity generators.
4	Spaces which fall under Group 4 are similar to those in Group 5 in that they **feature a curbless design**, have no or **very limited pedestrian crossing locations**, limited formal surface demarcation, and **frequently have a texturized driving surface**. These spaces, however, **more frequently have pedestrian safe zones** and standard road signs.
3	Group 3 spaces are those spaces which are **defined by low curbs or slight vertical separation** between users with a drainage gully. These spaces **frequently have no formal pedestrian crossing location**, and minimal road signs. These spaces often utilize **linear demarcation with material use**. Other features, such as the availability of pedestrian safe zones, presence of cafes, texturized driving surface, and the availability of free standing lamps vary widely between spaces in this group.
2	These spaces are defined by the **presence of pedestrian "safe zones"** and the **presence of formal, painted pedestrian crossings throughout the space**. While this is the case, these spaces still **feature low curbing**. Other features, such as road signs, cafes, surface demarcation, texturized driving surface, and the presence of free standing lamps, are not drastically different than that of Group 3, and vary widely among groups in these spaces.
1	The last group, Group 1, are similar to those in Group 2 with the exception that these spaces are the **only group which are defined by full height curbs**. They frequently feature standard road signs, high levels of surface demarcation, and traditional street lamps. Theses spaces may or may not have cafes present or feature a texturized driving surface.

Out of the total of 132 *shared spaces* studied for this project, 27 spaces were classified in the most shared Group 6 category, 26 in Group 5, 29 in Group 4, 30 in Group 3, 13 in Group 2, and 7 in Group 1. A summary of how these spaces are distributed within each group as well a summary of how these spaces were distributed amongst the countries is presented below in Table 8.

Table 8: A summary of the categorical and geographic distribution of *shared spaces* examined in this thesis

		Most Shared				*Least Shared*	
Region	***Country***	**6**	**5**	**4**	**3**	**2**	**1**
Asia	Japan	1	2	1	-	-	-
Europe	Austria	-	1	-	-	-	-
	Belgium	-	-	1	-	1	-
	Denmark	1	3	-	5	-	-
	France	-	-	-	1	1	-
	Germany	-	-	-	2	1	-
	Hungary	-	-	-	-	-	1
	Italy	-	-	-	-	1	-
	Netherlands	11	4	3	2	1	-
	Poland	-	-	1	1	-	-
	Portugal	-	-	1	1	-	-
	Spain	-	-	4	1	1	-
	Sweden	-	1	-	-	-	-
	Switzerland	1	-	1	1	-	-
	UK	7	3	6	4	4	2
North America	Canada	-	1	1	1	-	-
	Mexico	-	1	-	-	-	-
	USA	4	3	8	9	2	4
Oceania	Australia	-	-	1	1	-	-
	New Zealand	2	5	-	1	-	-
South America	Argentina	-	2	-	-	-	-
	Brazil	-	-	1	-	-	-
	Chile	-	-	-	-	1	-
	TOTAL	**27**	**26**	**29**	**30**	**13**	**7**

A summary of the context of these *shared spaces* based on network role and adjoining land form is also provided. This is of particular interest since it is recognized that these *shared space* environments, regardless of how they may or may not be designed, often play dramatically different roles within a particular urban environment and transportation system. For example, if planners are interested in using this research to find case studies of spaces that are "most shared" that serve the transportation system at a "neighborhood" scale and is located in the a T5 transect, a planner could easily see that that four spaces exist within this category. Using the full list of *shared spaces* in Section 14.0 Appendix D, it can be found that these spaces include Ipswich, UK (2 spaces); Wolvega, Netherlands; and Brighton, UK. This can provide planners with a valuable resource in determining compatible case studies for any potential projects.

The summary presented in Table 9 shows a few trends with regards to *shared space*. First, *shared space* schemes have been developed across a wide range of transportation facilities, and these serve the community in many different manners. While *shared space* is more commonly found in facilities of less regional importance, there remain several which have been designed on regional and city wide street facilities. Similarly, *shared spaces* are found within a wide range of urban environments. This includes the T6, or “City Core”, zone to smaller residential communities that fall closer to the T3, or “suburban”, zone. However, it can be seen from this summary that the vast majority of these *shared spaces* fall within T4 and T5 zones. This is perhaps due to a consequence of the character of these spaces. Frequently, these represent more “human scale” commercial corridors, for which *shared space* seems inherently compatible with.

Table 9: Summary of the contextual characteristics of the *shared spaces* evaluated in this thesis

			Network Role					
		SS Rank	**Regional**	**City**	**Neighbor-hood**	**Local**	**TOTAL**	**CONTEXT TOTAL**
Context	**T3**	***1***				1	1	5
		2	2				2	
		3	1				1	
		4						
		5						
		6				1	1	
	T4	***1***			1	1	2	53
		2	1	1	1	2	5	
		3	2	1	5	9	17	
		4	1	3	6	3	13	
		5		1	3	1	5	
		6	2		6	3	11	
	T5	***1***	2	1			3	52
		2	1	2	2	1	6	
		3	1	2	6	1	10	
		4	1		8	2	11	
		5		2	6	3	11	
		6	2		4	5	11	
	T6	***1***				1	1	22
		2						
		3		1	1		2	
		4		1	3	1	5	
		5				10	10	
		6		1		3	4	
NETWORK TOTAL			16	16	52	48		

In addition to the summary tables provided above, a complete list of the results is provided in Section 14.0 Appendix D.

7.2 Two Case Studies in Classifying Shared Spaces

In addition to providing decision makers with resources to find similar case studies to potential *shared space* schemes, it is also imperative that any proposed classification scheme is able to be easily adapted to classify new spaces. This allows such classification scheme to be used in further studies and gives researchers a framework for which to evaluate *shared space*.

Using this classification scheme marks a departure from the arbitrary 'points-base' rating scheme put forward by Shore & Uthayakumar (2010). This departure is quite intentional as it was recognized that small adjustments to the scoring weights could dramatically alter results. Furthermore, scoring based on a continuous scale reduces the opportunities to compare amongst others in the range, and to understand the differences in design.

Instead, this case study recommends comparing space characteristics against the attributes of each group given previously in Table 6. Those with a code which falls within 1 standard deviation of the mean of each group are given a point. A space which matches identically with the mean of a group characteristic (which in practice, will only be those space characteristics with a $\sigma = \pm 0$), will be given 3 points. All groups will be then tallied and compared against the scores of others to determine the group which the space fits the best. Other characteristics which were discarded due to the finding that they weren't significant are not necessary to collect.

7.2.1 Case Study 1: A Highly-Shared Environment by Design in Vienna, Austria

Case study 1 consists of a highly-shared environment on Mariahilferstrase in Vienna, Austria for which we would expect to get a high "sharedness" score. This facility, which exists within a dense commercial corridor near the heart of Vienna (transect score = T5), is somewhat of an extension of the densest heart of the commercial corridor in this area which is currently a pedestrian exclusive zone. The *shared space* portion of this street, however, represents an important link to the properties in the area, and serves as a "neighborhood" level facility. Figure 16 below shows a picture of this *shared space* as it exists today.

Figure 16: Mariahilferstrase *shared space* in Vienna, Austria
(Source: Google Maps Streetview)

Using this image, a summary of the relevant characteristics can be easily determined. This is presented below in Table 10.

Table 10: Characteristics of the Mariahilferstrase *shared space*

Characteristic	**Value**	**Code**
Curbs	No Curbs	8
Ped Safe Zones	Yes, Entirety	0
Ped Crossing	None	4
Road Signs	None	4
Cafes	Yes	1
Surface Demarcation	Low Contrast, Materials	2
Texturized Driving Surface	Yes	1
Free Standing Lamps	Yes, Street Lights	0

Finally, with these characteristics in hand, the Mariahilferstrase *shared space* can be easily tested against the previously defined six *shared space* characteristics to understand the best suited category for this space.

Table 11: Testing the characteristics of the Mariahilferstrase *shared space* against the characteristics of each group.

GROUP	**Curbs**	**Ped Safe Zones**	**Ped Crossing**	**Road Signs**	**Cafes**	**Surface Demarcation**	**Texturized Driving Surface**	**Free Standing Lamps**	**TOTAL**
6	*		*	*	*	*	*		6
5	***	*	***	***	*	*	*		13
4	***	*	*		*	*	*		8
3		*	*			*	*		4
2		*			*	*		*	4
1		*			*	*	*	*	5

Notice that in this case, there was no perfect group for this location. The presence of traditionally sized streetlamps meant that it did not meet all criteria for Group 5, but using the tallying method, it is clear that this space is the most suited for this group.

7.2.2 Case Study 2: A De Facto Shared Environment of Conventional Design in Storrs, Connecticut

Case Study 2 consists of a traditionally designed environment in the village center of Storrs, Connecticut. This environment, while highly pedestrianized, follows traditional design guidelines. It would be expected that this space ranks low on our *shared space* ranking.

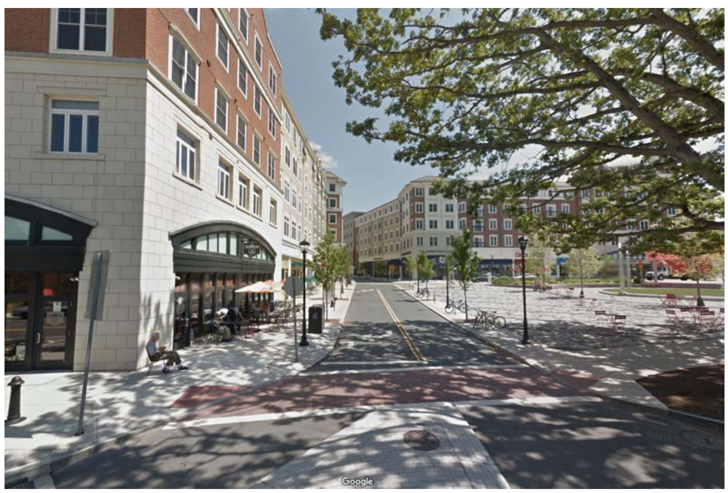


Figure 17: Dog Lane, Storrs, CT
(Source: Google Maps Streetview)

Table 12: Characteristics of the Storrs Center town center

Characteristic	Value	Code
Curbs	Yes, full	0
Ped Safe Zones	Yes, Entirety	0
Ped Crossing	High Contrast, Painted	0
Road Signs	Yes	0
Cafes	Yes	0
Surface Demarcation	High Contrast, Paint Lines	0
Texturized Driving Surface	No	0
Free Standing Lamps	Yes, Ped Scale	1

These characteristics can then be tested against the defined attributes of each group.

Table 13: Testing the characteristics of the Storrs Center space against the characteristics of each group.

GROUP	Curbs	Ped Safe Zones	Ped Crossing	Road Signs	Cafes	Surface Demarcation	Texturized Driving Surface	Free Standing Lamps	TOTAL
6					*			*	2
5					*			*	2
4		*			*			*	3
3		*						*	2
2		***	***		*		*	*	9
1	***	***		*	*			*	9

As demonstrated by Table 13, the discrepancies between Group 1 and Group 2 mean there is no "perfect" fit for the Storrs Center space. In reality, this space could be placed in either of these groups using this method.

7.3 Future Development of Shared Space

As the *shared space* concept continues to be developed, and the concept becomes more well known, proposals for new *shared space* schemes continue to appear. Here in the United States, where there are only a handful of these "highly shared" *shared space* concepts in existence (only seven within Group 5 and Group 6 based on this research, and all but one of those spaces on "local" roadways), the new concept remains quite novel. However, the benefits of these spaces have attracted developers and road safety advocates alike. After the development of several high-profile projects in cities such as Pittsburgh, Chicago, and Seattle, proposals are in motion for the development of several *shared space* concepts in Philadelphia (Schuylkill Yards, 2nd Street Station Plaza, Drury Street, Market East), Boston (Union Street), Washington, D.C. (Southwest Waterfront), and New York City (Madison Square) (Sauer & Mastaglio, 2017; ConnectBoston, 2014; Perkins Eastman, n.d.; NYCDOT, 2017). Examples of renderings of proposed designs for these spaces are provided below in Figure 18.

Figure 18: Examples of *shared space* schemes under consideration in the United States.
Top Left: Madison Square, NYC (NYCDOT, 2017). *Top Right*: Southwest Waterfront, Washington DC (Perkins Eastman, n.d.). *Bottom Left:* Union Street, Boston (ConnectBoston, 2014). *Bottom Right:* 2nd Street Station Plaza, Philadelphia (NV5, 2016)

8.0 Future Work

As discussed at length throughout this thesis, a proper classification scheme for *shared space* is not in of itself a destination for research. Indeed, as I have shown, the listing of *shared spaces* based on certain characteristics can be tremendously useful for potential decision makers looking at implementing such a design in their own city. However, the real opportunity for growth with such a classification scheme remains the framework this thesis developed for *shared*

space. As discussed in previous sections, the narrative up until this point has been looking at *shared space* as if it is one design category. However, as shown through this thesis, *shared space* often differs in both its design and its use. Understanding these differences can help inform decision as to how to address shortcomings in designs and to understand where *shared space* is an appropriate solution to design. In summary, the framework developed in this thesis will help frame the conversation as seen in Figure 19.

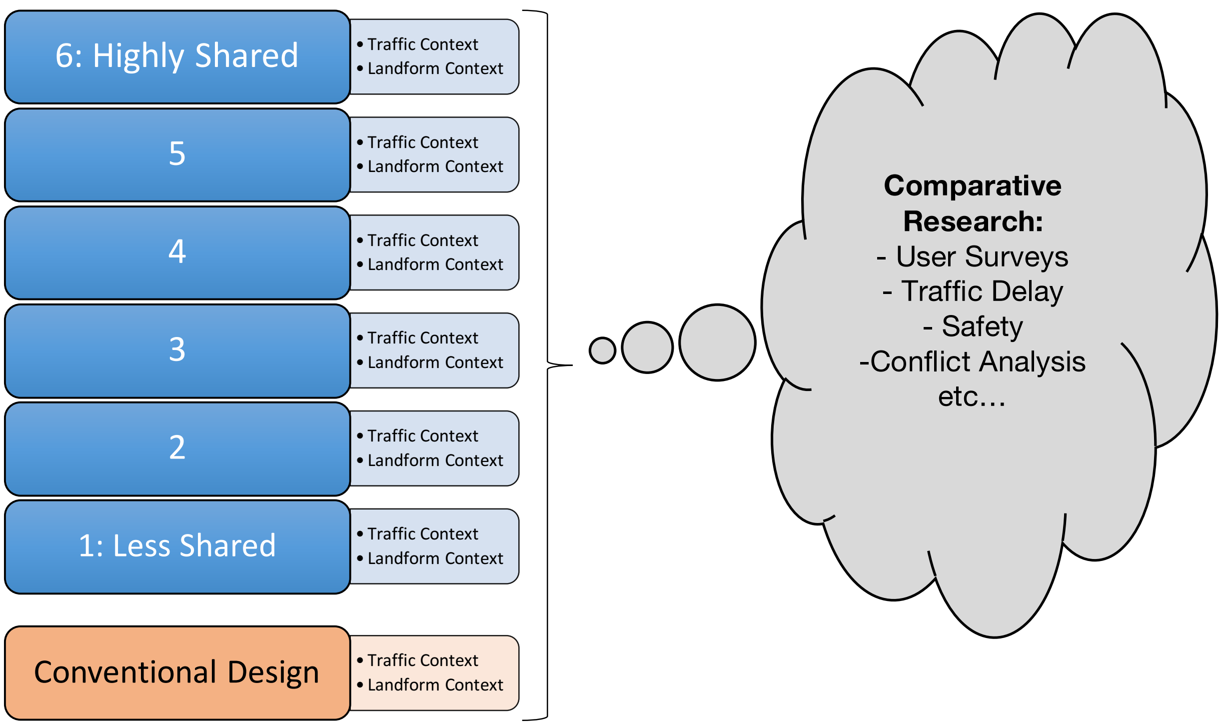


Figure 19: The framework proposed to guide discussion and research around *shared space*

Furthermore, increased understanding in the differences in design and use of these *shared space* concepts is critical to the further development of the concept. Currently, this *shared space* classification scheme relies entirely on design elements included in each space. However, it is clear that such elements do not necessitate entirely shared behavior, or even safe behavior. Development of a classification system based on the *use* and *interactions* present in these spaces

could aide in this understanding in the differences in design and use especially when used in conjunction with the classification method presented in this thesis.

9.0 Conclusions

As discussed throughout this thesis, understanding the way in which street space has been legally conceptualized is crucial to understanding the context for the development of shared space, and thus the state of the shared space design philosophy as it exists today. The context of the street has undergone tremendous change throughout the 20^{th} Century with the introduction of the automobile representing a seismic shift in the legal framework for the way in which we conceptualize our streets. Ultimately, the introduction of the automobile meant that the framework for our streets shifted to one which gave increased priority to automobile traffic, at the expense of the mobility of non-motorized users.

Only after decades under the segregated user design approach did engineers and decision makers begin to understand the way in which streets designed in this manner failed our communities. This hit particularly the hardest in urban commercial centers and neighborhoods, areas in which the mobility of the pedestrian and safety of children playing is of paramount concern. It was only after considering these other concerns that some traffic engineers began to recognize that it is not appropriate for the automobile to be such a dominant force in all urban settings, and soon there was work at an international level to introduce an integrated road user design scheme in specific contexts to reduce this dominance.

These design schemes were first developed internationally to reduce the dominance of vehicles in certain high pedestrian, low vehicle environments such as quiet residential streets or walkable commercial centers. Shortly after the introduction of these schemes, which included concepts such as *woonerfs* in the Netherlands, *home zones* in the United Kingdom, among others;

shared space was developed in the 1980's by Dutch traffic engineer Hans Monderman. Monderman's concepts worked to extend the similar integrated user design schemes that were previously developed by implementing his *shared space* concept in areas that saw higher volumes of traffic. Since the 1980's, *shared spaces* have been developed across the world, with each space being developed in slightly different context with slightly different design elements.

Recognizing this variety in design features, and in an effort to describe it, previous research proposed a point-based scoring system for *shared space* based on physical features included in design. It was recognized by the study authors, however, that such a scoring system is highly dependent on the variables included and the relative weights assigned to them. Therefore, such a scoring system is fairly arbitrary, and, depending how such a scoring system is developed, may not adequately capture the diversity in design of *shared space*.

To remedy this, this thesis presented a statistical methodology to classify *shared space* according to 17 separate design elements and contextual variables such as traffic, land-use, and physical design. The classification scheme was operationalized with data from 132 shared spaces around the world, which produced a typology of six distinct types of *shared space* based on several key characteristics. Variables which were found to have insignificant differences between the groups were not considered, leaving *shared space* to be determined based on a key set of eight physical design characteristics. Two case studies which demonstrated how such indicators could be used to classify *shared space* based on these design elements was then presented.

Finally, while it was recognized that such a classification system can help provide a framework for which to discuss shared space, it was noted that the results of this research need to be expanded upon in the future to fully understand the differences realized in operational outcomes by the wide variety of shared spaces currently in existence. In particular, previous

literature and surveys demonstrate that shared space frequently exhibits a varying degree of success in implementation. Further study to understand the relationship between the physical *shared space* design and the operational behavior of users is thus necessary to satisfactorily plan for these *shared space* design schemes into the future.

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11.0 Appendix A: Examples of Each Characteristic Value

Curbs / Vertical Separation	 *(Bendigo, Australia)* **No Curb**	 *(London, UK)* **Drainage Gully**	 *(Manchester, UK)* **Low Curb**	 *(Seaside, Florida)* **Full Curb**
Pedestrian "Safe Zones"	 *(Bendigo, Australia)* **None**	 *(Manchester, UK)* **Sporadic**	 *(Buenos Aires)* **Entirety**	
Surface Demarcation	 *(Auckland, New Zealand)* **No Contrast**	 *(Buenos Aires)* **Low Contrast, Materials**	 *(Bern, Switzerland)* **High Contrast, Paint**	
Pedestrian Crossing	 *(Auckland, New Zealand)* **None**	 *(Manchester, UK)* **Yes, Not Formal**	 *(Tokyo, Japan)* **Yes, Painted**	
Road Signs	 *(Buenos Aires, Argentina)* **None**	 *(Stuttgart, Germany)* **Minimal**	 *(Bern, Switzerland)* **Yes**	

Fences	 *(Buenos Aires, Argentina)* **None**	 *(Mexico City)* **Few, Intentional Obstructions**	 *(Normal, Illinois)* **Yes, Fences**
Free Standing Lamps	 *(Bendigo, Australia)* **None**	 *(Buenos Aires, Argentina)* **Yes, Pedestrian Scale**	 *(Bern, Switzerland)* **Yes, Full Streetlights**
Texturized Driving Surface	 *(Buenos Aires, Argentina)* **Yes**	 *(Stuttgart, Germany)* **No**	

12.0 Appendix B: Urban Transect Definition

(Center for Applied Transect Studies, n.d.)

13.0 Appendix C: Network Classification Definition

Network Connectivity Legend

A comparison to show the relative network scale. Each map is shown approximately at the same scale. The red highlight represents the shared space evaluated for this thesis.
(Source: Google Maps)

14.0 Appendix D: Shared Space Sample used for Classification and Results

The following represents the legend for the data result table presented below:

TRN SCT: Urban Transect Code
SHD SPC CAT: Shared Space Classification
Q1: Curbs
Q2: Bollards
Q3: Surface Demarcation
Q4: Ped Crossing
Q5: Road Signs
Q6: Fences
Q7: Lamps
Q8a: Cafes
Q8b: Seating
Q8c: Greenery
Q8d: Art
Q8e: Square
Q9: Texturized Driving Surface
Q10: Parking
Q11: Vehicle ROW Width [ft]

Country	City	Street Name	Lat	Long	Network Role	TRN SCT	SHD SPC CAT	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8a	Q8b	Q8c	Q8d	Q8e	Q9	Q10	Q11
Argentina	Buenos Aires	Bolivar	-34.609968	-58.37349	Local	6	5	8	0	2	4	4	3	1	1	1	1	0	1	1	1	15
Argentina	Buenos Aires	Bolivar - Intersection	-34.610236	-58.373494	Local	6	5	8	0	2	4	4	3	1	1	1	1	0	1	1	0	0
Australia	Bendigo	Bull / Hargreaves	-36.758626	144.282233	Neighborhood	4	4	8	6	2	2	4	3	2	1	1	1	0	1	1	0	0
Australia	Canberra	Bunda St	-35.27906	149.133258	City	5	3	8	0	2	4	0	3	0	1	0	1	1	1	0	1	0
Austria	Graz	Leechgasse	47.076184	15.450524	Neighborhood	5	5	8	2	2	4	4	3	1	0	1	0	0	1	1	0	0
Belgium	Oostend	Zandvoordestraat	51.216112	2.938559	City	4	2	4	0	0	0	2	3	0	1	0	1	0	0	0	1	24
Belgium	Oostend	Zandvoordestraat - Intersection	51.216945	2.935755	City	4	4	8	6	2	0	4	3	2	1	1	1	0	0	1	0	0
Brazil	Rio de Janeiro	R. Buenos Aires	-22.901966	-43.176857	Neighborhood	6	4	8	0	2	4	2	3	0	0	0	0	0	0	1	0	12
Canada	Montreal	Avenue Duluth E	45.517555	-73.578869	Neighborhood	4	5	8	2	2	4	4	3	1	1	1	1	0	0	1	1	14
Canada	Montreal	Avenue Duluth E - Intersection	45.5179	-73.578543	Neighborhood	4	3	8	2	2	4	0	3	1	1	1	1	0	0	1	0	0
Canada	Toronto	Front St. W	43.645609	-79.380697	Neighborhood	6	4	8	0	2	4	2	3	0	0	0	1	1	1	1	1	11
Chile	Santiago	Padre Alonso de Ovalle	-33.44712	-70.657096	Neighborhood	5	2	4	2	2	2	4	3	1	0	0	1	0	0	1	1	0
Denmark	Ejby	Algade	55.428565	9.927197	Regional	4	3	4	2	2	4	2	3	0	0	0	0	0	0	0	0	23
Denmark	Odense	Gronnengade	55.396675	10.379809	Local	4	3	4	2	2	4	4	3	2	0	1	1	1	1	1	0	15
Denmark	Copenhagen	Hauser Plads	55.682997	12.575463	Local	5	6	8	6	4	4	4	3	2	1	1	1	1	1	1	0	12
Denmark	Odense	Klingenberg	55.395103	10.38748	Neighborhood	4	3	6	0	2	4	4	3	1	0	1	1	0	1	1	0	28
Denmark	Christiansfeld	Lindegade / Kongensgagde	55.355482	9.48332	City	4	5	8	2	2	4	4	3	2	1	1	1	0	0	1	0	0
Denmark	Lyngby	Lyngby Hovedgade	55.76931	12.505031	City	5	5	8	0	2	4	4	3	1	1	1	1	0	0	1	1	16
Denmark	Odense	Sortebrodre	55.398493	10.392722	Local	4	3	4	0	2	4	2	3	1	1	1	1	0	1	1	1	10
Denmark	Copenhagen	Vester Voldgade	55.673277	12.575549	Neighborhood	5	3	4	0	2	4	4	3	1	0	1	1	1	0	1	0	11
Denmark	Aarhus	Vestergade	56.157623	10.207191	Neighborhood	5	5	8	2	4	4	2	3	2	0	1	1	0	0	1	0	0
France	Bordeux	Rue Georges Bonnac	44.840299	-0.582863	Local	5	3	4	0	4	4	4	3	1	0	1	1	0	1	1	0	10
France	Bordeux	Rue Georges Bonnac - Intersection	44.840299	-0.582863	Local	5	2	4	0	4	4	2	3	1	0	1	1	0	1	1	0	0
Germany	Hannover	Haspelmathstrabe	52.360622	9.71902	Local	4	3	4	2	2	4	2	3	1	0	0	1	0	0	1	1	12
Germany	Hannover	Haspelmathstrabe - Intersection	52.359836	9.719773	Local	4	3	8	0	2	4	2	3	2	0	0	1	0	0	1	1	0
Germany	Stuttgart	Tubinger Strasse	48.771247	9.173652	Neighborhood	5	2	4	0	2	0	2	3	2	0	1	1	0	0	0	1	24
Hungary	Debrecen	Piac u.	47.530142	21.624834	Regional	5	1	0	0	2	2	2	1	0	1	1	1	1	1	1	0	30
Italy	Milano	Via Amerigo Vespucci	45.480824	9.192858	Local	4	2	4	0	2	0	2	3	1	1	0	1	0	0	1	1	9
Japan	Tokyo	Chome / Nishiikebukuro	35.732637	139.710121	Local	6	6	8	6	2	4	4	3	1	1	0	0	0	0	1	0	12
Japan	Tokyo	Chome / Nishiikebukuro - Intersection	35.732637	139.710121	Local	6	4	8	6	0	0	4	3	1	1	0	0	0	0	1	0	0
Japan	Tokyo	Muromachi	35.687016	139.774338	Local	6	5	8	2	2	4	4	3	2	1	1	1	1	0	1	0	18
Japan	Tokyo	Muromachi - Intersection	35.687016	139.774338	Local	6	5	8	2	2	4	4	3	2	1	1	1	1	1	1	0	0
Mexico	Mexico City	Angela Peralta	19.435516	-99.141853	Local	6	5	8	0	4	4	4	1	0	0	1	1	1	1	1	0	24
Netherlands	Makkinga	Brink / Bercoperweg	52.981293	6.217837	Regional	3	3	4	2	2	4	2	3	1	0	1	1	0	1	1	0	20
Netherlands	Makkinga	Brink / Bercoperweg - Intersection	52.980713	6.217488	Regional	3	2	4	0	2	4	2	3	1	0	1	1	0	1	1	0	0
Netherlands	Oosterwolde	Brinkstraat	52.993223	6.293899	Neighborhood	4	6	8	6	4	4	4	3	2	1	1	1	1	1	1	1	0
Netherlands	Drachten	De Kaden	53.106772	6.101045	City	5	3	8	2	2	0	2	3	1	1	1	1	0	1	1	0	0
Netherlands	Culemborg	Het Jach	51.955366	5.224432	Neighborhood	4	6	8	6	2	4	4	3	1	0	0	0	0	0	1	0	10
Netherlands	Culemborg	Het Jach - Intersection	51.955366	5.224432	Neighborhood	4	5	8	2	2	4	4	3	1	0	1	1	0	0	1	0	0
Netherlands	Oosterwolde	Het Oost	52.994986	6.296561	Neighborhood	4	6	8	6	4	2	4	3	1	0	0	1	0	0	1	0	18
Netherlands	Oosterwolde	Het Oost - Intersection	52.994986	6.296561	Neighborhood	4	6	8	6	4	2	4	3	1	0	0	1	0	0	1	1	0
Netherlands	Emmen	Hoofdstraat	52.788046	6.894806	Neighborhood	5	4	8	2	2	4	2	3	1	1	1	1	0	0	1	1	20
Netherlands	Wolvega	Hoofdstraat Oost	52.876392	6.001681	Neighborhood	5	5	8	2	2	4	4	3	1	1	1	1	1	1	1	0	12
Netherlands	Wolvega	Hoofdstraat Oost - Intersection	52.876392	6.001681	Neighborhood	5	6	8	6	2	4	4	3	1	1	1	1	1	1	1	0	0
Netherlands	Drachten	Laweiplein	53.103042	6.09864	Regional	5	4	4	6	0	0	2	3	1	1	1	0	0	0	0	0	0
Netherlands	Leeuwarden	Prins Hendrikstraat / Zaailand	53.198951	5.792253	Regional	5	6	4	6	2	4	4	3	1	1	0	0	0	0	1	0	22

Country	City	Street Name	Lat	Long	Network Role	TRN SCT	SHD SPC CAT	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8a	Q8b	Q8c	Q8d	Q8e	Q9	Q10	Q11
Netherlands	Leeuwarden	Prins Hendrikstraat / Zaailand - Intersection	53.199433	5.792338	Regional	5	6	8	6	4	4	4	3	1	1	1	1	0	1	1	0	0
Netherlands	Haren	Rijksstraatweg	53.172747	6.603731	Regional	4	6	8	6	2	4	4	3	1	1	1	1	0	1	0	0	20
Netherlands	Haren	Rijksstraatweg - Intersection	53.173128	6.603148	Regional	4	6	8	6	2	4	4	3	1	1	1	1	0	1	1	1	0
Netherlands	Zaandam	Rozengracht	52.438507	4.81973	Local	4	5	8	2	4	4	4	3	1	1	1	1	0	1	1	1	12
Netherlands	Dokkum	Stoobossertrekvaart (N910)	53.299942	6.067479	Neighborhood	2	6	8	6	4	0	2	3	1	0	0	0	0	0	0	0	16
Netherlands	Dokkum	Stoobossertrekvaart (N910) - Intersection	53.299942	6.067479	Neighborhood	4	4	8	6	4	0	2	3	1	0	0	0	0	0	1	0	0
Netherlands	Oosterbeek	Weverstraat	51.986241	5.844019	Neighborhood	4	5	8	2	2	4	4	3	1	1	1	1	0	0	1	1	10
Netherlands	Oosterbeek	Weverstraat - Intersection	51.986241	5.844019	Neighborhood	4	6	8	6	2	4	4	3	1	1	1	1	0	0	1	0	0
New Zealand	Auckland	Darby/Elliot	-36.84946	174.764157	Local	6	5	8	2	4	4	4	3	1	1	1	1	0	1	1	1	10
New Zealand	Auckland	Darby/Elliot - Intersection	-36.84946	174.764157	Local	6	5	8	2	4	4	2	3	1	1	1	1	0	1	1	0	0
New Zealand	Auckland	Fort/Jean Batten Pl	-36.846018	174.766997	Local	6	5	8	0	4	4	4	3	0	1	1	1	0	0	1	0	18
New Zealand	Auckland	Fort/Jean Batten Pl - Intersection	-36.846004	174.76702	Local	6	5	8	2	4	4	2	3	0	1	1	1	0	0	1	0	0
New Zealand	Auckland	Lorne St	-36.851635	174.765031	Local	6	6	8	6	4	4	4	3	1	0	1	1	0	1	1	0	16
New Zealand	Auckland	Lorne St - Intersection	-36.852158	174.764808	Local	6	6	8	6	4	4	4	3	1	0	1	1	0	0	1	0	0
New Zealand	Auckland	O'Connell St	-36.847086	174.767212	Local	6	5	8	2	4	4	4	3	2	1	1	1	0	0	1	0	9
New Zealand	Auckland	Totara Ave	-36.909382	174.681886	Local	4	3	6	0	2	4	2	3	0	0	1	1	0	0	1	1	23
Poland	Lodz	6 Sierpnia / Piotrkowska	51.768698	19.456395	Neighborhood	5	4	8	2	4	4	2	3	1	1	1	1	0	0	1	1	20
Poland	Lodz	6 Sierpnia / Piotrkowska - Intersection	51.768698	19.456395	Neighborhood	5	3	8	2	4	2	0	3	1	1	1	1	0	0	1	0	0
Portugal	Braga	R. Dom Afonso Henriques	41.549532	-8.424033	Neighborhood	5	4	8	0	0	4	2	3	2	1	1	1	1	1	1	1	12
Portugal	Braga	R. Dom Afonso Henriques - Intersection	41.549196	-8.423144	Neighborhood	5	3	8	0	0	4	2	3	2	1	1	1	1	1	1	1	0
Spain	Madrid	Calle Libreros	40.421564	-3.706667	Local	4	4	8	2	4	4	2	3	1	0	0	1	0	0	1	0	12
Spain	Madrid	Calle Libreros - Intersection	40.422163	-3.706347	Local	4	3	8	0	2	4	2	3	1	0	0	1	0	0	1	0	0
Spain	Madrid	Calle Marques de Leganes	40.422099	-3.70701	Local	4	4	8	0	2	4	2	3	1	0	0	1	0	0	1	0	15
Spain	Barcelona	Carrer d'Hondures	41.421522	2.187695	Local	5	4	8	0	2	4	2	3	1	1	1	1	0	0	1	0	12
Spain	Bilbao	Don Diego Lopez	43.262015	-2.930359	City	5	2	8	0	2	0	2	3	0	1	1	1	0	0	0	0	24
Spain	San Sebastian	Zabaleta	43.324051	-1.97476	Neighborhood	5	4	8	0	2	4	2	3	0	1	1	1	0	1	1	0	14
Sweden	Norrkoping	Kungsgaten	58.590443	16.178583	City	5	5	8	2	4	4	4	3	1	1	1	1	0	1	1	0	0
Switzerland	St. Gallen	Schreinerstrasse	47.422061	9.373218	Local	5	6	8	6	4	4	4	3	2	1	1	1	1	1	1	0	15
Switzerland	Bern	Schwarzenburgstrasse	46.923212	7.414742	Regional	4	4	8	0	2	4	0	3	0	1	1	0	1	0	0	0	30
Switzerland	Bern	Schwarzenburgstrasse - Intersection	46.923212	7.414742	Regional	4	3	8	0	0	2	0	3	0	1	1	0	1	0	0	0	0
UK	Newbury	Bartholomew St	51.400526	-1.324486	Neighborhood	5	4	8	2	2	4	2	3	0	1	1	1	0	0	1	0	20
UK	Newcastle	Blackett St	54.97399	-1.613064	City	6	6	4	6	2	4	4	3	2	1	1	0	1	1	1	0	12
UK	Dorchester	Bridport Rd	50.712244	-2.462821	Regional	4	2	4	2	4	2	4	3	2	1	1	1	0	0	0	1	0
UK	Caemarfon	Castle Square	53.139427	-4.275079	Neighborhood	5	5	8	2	2	4	4	3	2	1	1	1	0	1	1	1	12
UK	Plymouth	Charlotte St	50.37966	-4.177859	Local	4	4	8	0	2	4	2	3	0	0	1	1	0	0	1	1	10
UK	Plymouth	Charlotte St - Intersection	50.380255	-4.178048	Local	4	6	8	6	2	4	4	3	1	0	1	1	0	0	1	1	0
UK	London	Exhibition Road	51.497984	-0.174023	City	6	3	6	0	2	4	2	3	0	0	1	0	0	1	1	1	25
UK	London	Exhibition Road - Intersection	51.500044	-0.174498	City	6	4	6	6	2	2	2	3	0	0	1	0	0	1	0	0	0
UK	Manchester	George Leigh St	53.485704	-2.227743	Neighborhood	4	3	4	2	2	2	4	3	0	0	1	1	0	0	0	1	11
UK	Manchester	George Leigh St - Intersection	53.485704	-2.227743	Neighborhood	4	4	8	6	2	2	4	3	2	0	1	1	0	0	1	0	0
UK	Coventry	Gosford St	52.406729	-1.504148	Neighborhood	4	2	4	2	2	2	2	3	0	0	0	0	0	0	0	0	0
UK	Hereford	High St/Widemarsh St	52.056461	-2.716554	Local	5	6	8	6	2	4	4	3	2	1	1	0	1	1	1	0	10
UK	London	Kensington High	51.499687	-0.196756	Regional	5	1	0	0	0	0	0	3	0	0	0	1	0	0	0	0	44
UK	Harlow	Langdale St	51.771473	0.135412	Local	4	6	8	6	2	2	4	3	2	0	1	1	0	1	1	1	15
UK	Southend-on-Sea	Marine Parade	51.532838	0.722212	City	5	2	4	2	2	4	4	3	0	1	1	1	0	0	1	0	0
UK	Brighton	New Road	50.823319	-0.139457	Neighborhood	5	6	8	6	4	4	0	3	1	1	1	1	1	1	1	1	14

Country	City	Street Name	Lat	Long	Network Role	TRN SCT	SHD SPC CAT	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8a	Q8b	Q8c	Q8d	Q8e	Q9	Q10	Q11
UK	Poynton	Park Lane / A523	53.348698	-2.118836	Regional	5	3	4	2	2	2	4	3	0	1	1	1	0	0	0	0	16
UK	Poynton	Park Lane / A523 - Intersection	53.349261	-2.122258	Regional	5	2	4	2	2	2	4	3	0	1	1	1	0	0	1	0	0
UK	Weston-super-Mare	Princess Royal Square	51.346582	-2.980663	Local	5	5	8	2	2	4	4	3	0	1	1	1	1	1	1	0	24
UK	London	Seven Dials	51.513797	-0.126912	Neighborhood	5	5	8	2	2	4	2	3	2	1	1	1	1	1	1	0	0
UK	London	Sloan Square	51.492335	-0.156642	Neighborhood	5	4	8	2	2	4	0	3	0	1	0	1	0	0	1	0	12
UK	Bristol	Station Approach	51.449574	-2.581176	Local	3	1	0	0	2	4	4	3	1	0	1	0	0	0	1	1	30
UK	Ipswich	Tavern St	52.057822	1.153848	Neighborhood	5	6	6	6	2	4	4	3	1	1	1	1	0	1	1	0	20
UK	Ipswich	Tavern St - Intersection	52.057726	1.154648	Neighborhood	5	6	6	6	2	4	4	3	1	1	1	1	0	1	1	0	0
UK	Ashford	Elwick Square	51.147837	0.870634	Neighborhood	4	3	4	2	0	4	4	3	2	1	1	0	0	0	1	0	12
UK	Ashford	Elwick Square - Intersection	51.146821	0.869931	Neighborhood	4	4	8	6	2	2	4	3	0	0	1	1	0	1	1	0	0
USA	Jacksonville Beach	1st St N	30.291016	-81.390022	City	4	4	8	0	2	2	0	3	1	1	0	0	0	0	1	0	22
USA	Seattle	45th Ave South	47.525198	-122.275873	Local	3	6	8	6	4	4	2	3	0	0	0	1	0	0	0	1	11
USA	Chicago	Argyle Street	41.973344	-87.656597	Neighborhood	5	5	8	0	2	4	4	3	0	1	0	1	0	0	1	1	16
USA	Chicago	Argyle Street - Intersection	41.973276	-87.657724	Neighborhood	5	3	8	0	2	4	0	3	0	1	0	1	0	0	1	0	0
USA	Seattle	Bell St	47.613744	-122.345993	Neighborhood	4	4	8	0	4	4	2	3	1	1	1	1	0	0	1	1	15
USA	Washington	Cady's Alley	38.904652	-77.066732	Local	5	6	8	6	2	4	4	3	2	1	1	1	0	0	1	0	8
USA	Seaside	Central Square	30.32023	-86.137203	Local	4	1	0	0	2	4	2	3	1	1	1	1	0	1	1	1	28
USA	Seaside	Central Square - Intersection	30.32023	-86.137203	Local	4	2	6	2	2	4	2	1	1	1	1	1	0	1	1	1	0
USA	Sulphur Springs	College St	33.137805	-95.600805	Regional	3	2	6	0	2	0	2	3	1	1	1	1	1	1	1	1	22
USA	Normal	Constitution Blvd	40.509227	-88.98436	Neighborhood	4	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0
USA	Birmingham	Dexter Ave	32.377247	-86.309149	Neighborhood	5	3	6	0	2	0	2	3	0	0	1	1	1	0	1	0	0
USA	Eugene	E Broadway / Willamette	44.049898	-123.092805	City	4	4	8	0	2	4	0	3	1	1	1	1	0	0	0	1	18
USA	Eugene	E Broadway / Willamette - Intersection	44.049898	-123.092805	City	4	3	8	2	2	4	0	3	1	1	1	1	0	0	1	0	0
USA	Pittsburgh	Forbes Ave	40.440864	-80.002288	Neighborhood	6	4	8	0	2	2	2	3	1	1	1	1	0	1	1	1	19
USA	Pittsburgh	Forbes Ave - Intersection	40.440697	-80.002685	Neighborhood	6	3	8	0	2	2	2	3	1	1	1	1	0	1	1	1	0
USA	Indianapolis	Georgia Street	39.764391	-86.160793	Local	5	5	8	2	2	4	4	3	1	1	1	1	1	1	1	0	16
USA	Kalamazoo	Kalamazoo Mall	42.289203	-85.583105	Neighborhood	5	3	6	0	2	4	2	3	1	1	1	1	0	0	0	1	12
USA	San Francisco	Linden St	37.776395	-122.423033	Local	4	3	4	0	0	4	2	3	0	0	1	1	0	0	0	1	17
USA	Santa Monica	Longfellow St	34.002951	-118.471902	Local	4	6	8	6	2	4	0	3	1	0	0	1	0	0	0	1	12
USA	Santa Monica	Longfellow St - Intersection	34.002686	-118.471704	Local	4	3	8	2	2	2	0	3	1	0	0	1	0	0	1	1	0
USA	Batavia	N River St	41.850595	-88.306049	Neighborhood	4	4	8	0	4	4	2	3	1	1	1	1	1	1	1	1	24
USA	Batavia	N River St - Intersection	41.850595	-88.306049	Neighborhood	4	3	8	0	4	4	2	3	1	1	1	1	1	1	1	1	0
USA	Portland	NW Davis St	45.524562	-122.673908	Neighborhood	5	4	8	0	2	4	2	3	1	0	1	1	0	0	1	1	24
USA	Portland	NW Flanders St	45.525971	-122.673849	Neighborhood	5	4	8	0	2	4	2	3	1	0	1	1	0	0	1	1	24
USA	Cambridge	Palmer St	42.373842	-71.120044	Local	5	6	8	6	4	4	4	3	1	0	1	0	0	0	1	0	15
USA	Seattle	Pike Pl	47.608789	-122.340343	Local	6	1	0	0	2	4	0	3	0	1	1	1	0	1	1	1	22
USA	West Palm Beach	S Rosemary Ave	26.713154	-80.057063	Local	4	3	4	0	2	4	2	3	1	0	0	1	1	0	1	1	24
USA	Seattle	Terry Ave North	47.622744	-122.337178	City	5	1	0	0	0	2	0	3	1	1	1	1	1	1	0	1	24
USA	Asheville	Wall Street	35.594613	-82.555903	Local	5	5	8	0	2	4	4	3	1	1	1	1	0	0	1	1	10
USA	Cambridge	Winthrop St	42.372303	-71.120883	Local	5	4	8	2	2	4	2	3	1	1	1	1	0	1	1	0	12

15.0 Appendix E: Complete Statistical Results

GROUP	Curbs	Ped Safe Zones	Ped Crossing	Road Signs	Cafes	Surface Demarcation	Texturized Driving Surface	Free Standing Lamps
Values	*[0,4,6,8]*	*[0,2,6]*	*[0,2,4]*	*[0,2,4]*	*[0,1]*	*[0,2,4]*	*[0,1]*	*[0,1,2]*
6	7.44 ± 1.34	6.00 ± 0.00	3.61 ± 1.04	3.33 ± 1.37	0.56 ± 0.51	2.94 ± 1.00	0.78 ± 0.43	1.28 ± 0.58
5	8.00 ± 0.00	1.38 ± 1.20	4.00 ± 0.00	4.00 ± 0.00	0.94 ± 0.25	2.63 ± 0.96	1.00 ± 0.00	0.94 ± 0.68
4	8.00 ± 0.00	0.57 ± 0.93	3.81 ± 0.60	1.62 ± 0.81	0.67 ± 0.48	2.29 ± 0.96	0.90 ± 0.30	0.71 ± 0.56
3	4.50 ± 0.89	0.94 ± 1.12	3.75 ± 0.68	2.88 ± 1.03	0.25 ± 0.45	1.94 ± 0.93	0.69 ± 0.47	0.75 ± 0.68
2	5.20 ± 1.79	0.00 ± 0.00	0.00 ± 0.00	2.20 ± 0.45	0.80 ± 0.45	1.60 ± 0.89	0.40 ± 0.55	0.80 ± 0.84
1	0.00 ± 0.00	0.00 ± 0.00	2.67 ± 1.63	1.33 ± 1.63	0.67 ± 0.52	1.33 ± 1.03	0.67 ± 0.52	0.50 ± 0.55
Total	6.44 ± 2.44	1.91 ± 2.37	3.48 ± 1.21	2.72 ± 1.35	0.62 ± 0.49	2.32 ± 1.05	0.80 ± 0.40	0.88 ± 0.66

GROUP	Fence	Benches	Greenery	Art	Public Square	Parking
Values	*[0,1,3]*	*[0,1]*	*[0,1]*	*[0,1]*	*[0,1]*	*[0,1]*
6	3.00 ± 0.00	0.61 ± 0.50	0.61 ± 0.50	0.28 ± 0.46	0.50 ± 0.51	0.22 ± 0.43
5	2.88 ± 0.50	0.94 ± 0.25	1.00 ± 0.00	0.31 ± 0.48	0.50 ± 0.52	0.56 ± 0.51
4	3.00 ± 0.00	0.71 ± 0.46	0.86 ± 0.36	0.19 ± 0.40	0.29 ± 0.46	0.52 ± 0.51
3	3.00 ± 0.00	0.81 ± 0.40	0.81 ± 0.40	0.19 ± 0.40	0.38 ± 0.50	0.50 ± 0.52
2	3.00 ± 0.00	0.60 ± 0.55	1.00 ± 0.00	0.20 ± 0.45	0.20 ± 0.45	0.80 ± 0.45
1	2.67 ± 0.82	0.83 ± 0.41	0.83 ± 0.41	0.33 ± 0.52	0.67 ± 0.52	0.67 ± 0.52
Total	2.95 ± 0.31	0.76 ± 0.43	0.83 ± 0.38	0.24 ± 0.43	0.41 ± 0.50	0.49 ± 0.50

16.0 Appendix G: Visual Examples of Shared Spaces by Classification

SS Class	*Link*	*Intersection*
6	 Het Jach, Culemborg, Netherlands	 Charlotte Street, Plymouth, United Kingdom
5	 Rozengracht, Zaandam, Netherlands	 Muromachi, Tokyo, Japan
4	 Bell Street, Seattle, Washington	 Kensington High Street, London, United Kingdom

SS Class	*Link*	*Intersection*
3	 Gronnengade, Odense, Denmark	 R. Dom Alfonson Henriques, Braga, Portugal
2	 Stuttgart, Germany	 Coventry, United Kingdom
1	 Piac U., Debrecen, Hungary	 Uptown Circle, Normal, Illinois

17.0 Appendix F: Other Known Shared Space Design Schemes

City	Country	Street Name	Source
Bankstown	Australia	Chapel Road	(Gillies, 2009)
Cronulla	Australia	Eton Street	(Gillies, 2009)
Cronulla	Australia	Sutherland Street	(Gillies, 2009)
Cronulla	Australia	Cronulla Street	(Gillies, 2009)
Kensington	Australia	UNSW	(Gillies, 2009)
King Street Place	Australia	Rockdale	(Gillies, 2009)
Melbourne	Australia	Melbourne CBD	(Gillies, 2009)
Sydney	Australia	Barrack St	(Gillies, 2009)
Sydney	Australia	Sydney Opera House	(Gillies, 2009)
Sydney	Australia	Sydney Olympic Park	(Gillies, 2009)
The Rocks	Australia	Jack Mundey Place	(Gillies, 2009)
Aberdeen	UK	Green Area, Old Merchant Quarter and Cults	(Holmes, 2015)
Altrincham	UK	Town Centre	(Holmes, 2015)
Aylesbury	UK	Friarage Road / Bourg Walk	(Holmes, 2015)
Ayr	UK	Dunure Road	(Holmes, 2015)
Barnstaple	UK	Around Old Bus Station, The Strand	(Holmes, 2015)
Bath	UK	Julian Road	(Holmes, 2015)
Birmingham	UK	John Bright Street. Longbridge	(Holmes, 2015)
Blackpool	UK	Promenade & Central Business District	(Holmes, 2015)
Bournemouth	UK	Boscombe. Horseshoe Common	(Holmes, 2015)
Bradford upon Avon	UK	Town Centre	(Holmes, 2015)
Bridlington	UK	Promenade (Victor from Leeds told me)	(Holmes, 2015)
Bristol	UK	Ashton Court	(Holmes, 2015)
Buckden	UK	Lucks Lane	(Holmes, 2015)
Buntingford	UK	Across the town	(Holmes, 2015)
Bury	UK	The Haymarket	(Holmes, 2015)
Bury St Edmunds	UK	St Andrew's Street South	(Holmes, 2015)
Cambridge	UK	Fitzroy Street	(Holmes, 2015)
Carmarthen	UK	King's Street	(Holmes, 2015)
Cheltenham	UK	Boots Corner	(Holmes, 2015)
Chester	UK	Little John Street	(Holmes, 2015)
Church Crookham	UK		(Holmes, 2015)
Cirencester	UK	Market Place	(Holmes, 2015)
Coventry	UK	Little Park Street, Corporation Street, Junction of Trinity Street and Hales Street, Cox Street	(Holmes, 2015)
Derby	UK	Downham, Bromley Road	(Holmes, 2015)
Dunstable	UK	Court Drive	(Holmes, 2015)
Durham	UK	Market Square. Saddler Street	(Holmes, 2015)
Edinburgh	UK	Granton	(Holmes, 2015)
Ely	UK	Market Place	(Holmes, 2015)
Felixstowe	UK	Town Centre	(Holmes, 2015)
Gloucester	UK	Stonehouse. Southgate Street/Commercial Way. Kimbrose Way	(Holmes, 2015)
Grimsby	UK	Town Centre	(Holmes, 2015)
Hull	UK	Jamieson Street, King Edward's Street. Whitefriargate. Victoria Square	(Holmes, 2015)
Isle of Man	UK	Douglas Promenade	(Holmes, 2015)
Kilmarnock	UK	Town wide integrated urban development plan	(Holmes, 2015)
Kingston upon Thames	UK	Near the Guildhall	(Holmes, 2015)
Kinross	UK	High Street	(Holmes, 2015)
Kirkintulloch	UK	Town Centre	(Holmes, 2015)
Leeds	UK	Briggate	(Holmes, 2015)

Leek	UK	Ballhaye Street.	(Holmes, 2015)
Leicester	UK	Jubilee Square. High Street. St Nicholas Circle. The Parade. Oadby	(Holmes, 2015)
Leigh on Sea	UK	The Broadway	(Holmes, 2015)
Letchworth Garden City	UK		(Holmes, 2015)
Lewes	UK	The Cliffe	(Holmes, 2015)
London	UK	Acton, King Street	(Holmes, 2015)
London	UK	Bedford Square	(Holmes, 2015)
London	UK	Belvedere Road, SE1	(Holmes, 2015)
London	UK	Bexley Heath	(Holmes, 2015)
London	UK	Byng Place, N1	(Holmes, 2015)
London	UK	Covent Garden	(Holmes, 2015)
London	UK	Earls Court Road	(Holmes, 2015)
London	UK	Fitzroy Square	(Holmes, 2015)
London	UK	Hackbridge	(Holmes, 2015)
London	UK	Highbury and Islington	(Holmes, 2015)
London	UK	High Hill Ferry Lea Navigation	(Holmes, 2015)
London	UK	Islington	(Holmes, 2015)
London	UK	Judd Street	(Holmes, 2015)
London	UK	Kings Cross Station	(Holmes, 2015)
London	UK	Kings Road	(Holmes, 2015)
London	UK	Leonard Street	(Holmes, 2015)
London	UK	Lucks Lane	(Holmes, 2015)
London	UK	Lower Marsh	(Holmes, 2015)
London	UK	New Street Square, EC4	(Holmes, 2015)
London	UK	Pinner Hill Esate	(Holmes, 2015)
London	UK	Plumstead	(Holmes, 2015)
London	UK	Rivington Street	(Holmes, 2015)
London	UK	St Johns Road, SW11	(Holmes, 2015)
London	UK	Strutton Ground	(Holmes, 2015)
London	UK	Torrington Place	(Holmes, 2015)
London	UK	Twickenham	(Holmes, 2015)
London	UK	Pinner Hill Estate	(Holmes, 2015)
London	UK	Walthamstow	(Holmes, 2015)
London	UK	West Ealing	(Holmes, 2015)
London	UK	Whitton	(Holmes, 2015)
London	UK	Whipps Cross Road	(Holmes, 2015)
London	UK	Venn Street	(Holmes, 2015)
Lowestoft	UK	Gordon Road & Milton Road East	(Holmes, 2015)
Manchester	UK	Chapel Street	(Holmes, 2015)
Market Harborough	UK	Fardon Road	(Holmes, 2015)
Newbury	UK	Town Centre	(Holmes, 2015)
Newcastle	UK	Near Grainger Market	(Holmes, 2015)
Newcastle under Lyme	UK		(Holmes, 2015)
Norwich	UK	Pottergate. Queens Street	(Holmes, 2015)
Nottingham	UK	Ironmarket. Broad Street. Heathcoate Street. Carlton Street. Goose Gate. Pelham Street Beeston.	(Holmes, 2015)
Orpington	UK	Paddock Wood	(Holmes, 2015)
Oxford	UK	Queen Street	(Holmes, 2015)
Plymouth	UK	Ker Street	(Holmes, 2015)
Pontypridd	UK	Town centre	(Holmes, 2015)
Portsmouth	UK	South of Palmerston Road	(Holmes, 2015)
Poundbury	UK	Queen Mother Square	(Holmes, 2015)
Preston	UK	Fishergate	(Holmes, 2015)
Reading	UK	Town centre	(Holmes, 2015)

Sevenoaks	UK	Sevenoaks Station	(Holmes, 2015)
Shifnal	UK	All town	(Holmes, 2015)
Stoke on Trent	UK	Hanley. Basford Bank. Albion Street. Stafford Street	(Holmes, 2015)
Swindon	UK	Regent Circus	(Holmes, 2015)
Totnes	UK	High Street	(Holmes, 2015)
Warwick	UK	High street	(Holmes, 2015)
Whitehaven	UK	Stand Street, East Strand, Market Place junction	(Holmes, 2015)
Winchester	UK	High Street	(Holmes, 2015)