

Design For All

Transport and Urban Design

Guest Editor: Dr. Kenneth Joh, Texas A&M University



BUILT ENVIRONMENT



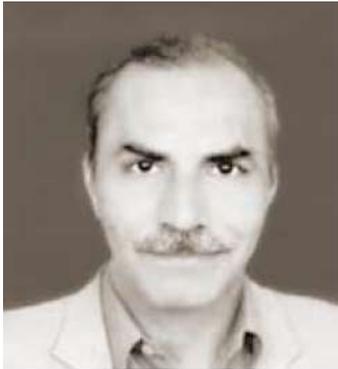
WALKABILITY



BIKEABILITY



Chairman's Desk:



Dr. Sunil Bhatia

We give heat or take it out from some elements which have inbuilt physical or chemical characteristics. Elements have varied level of change. What we are attempting by citing such examples from the past to remind our present designers that it is old practice of using the "role of surface area" in their design and it is nothing new. This phenomenon has existed before the story of 'Adam & Eve' and had surfaced in new shapes as technological advance. What we see today about the surface of the earth is not the same as that was in the beginning after big bang and reason of change is because of change in the behavior of surface area. Role of surface area in design was known to primitive man since he started living in groups and then they had designed sharp stones for killing the animals for food. As technology improved nature of tools also changed. Major change had come because of better knowledge in the field of surface area. 'Is sharpening not based on surface area?' Museums are displaying various tools or pots either made with mud or various metals. They indicate us that people of every civilization were aware about role of surface area in design and dissipation of knowledge was uniform. Modern man has more knowledge compared to our

ancestors. We are better equipped with modern technologies that are far superior & can enhance the knowledge of domain of physical, biological and chemical fields, making us to venture into unexplored areas for the use of society. Our knowledge is capable in exploring surface area in designing various devices at the level less than atom under the nanotechnology and in some areas results are wonderful. Ancient man was aware about surface impact- the physical sensation objects we touch influences our more abstracts feelings. He was astonished to observe when lizard changes its surface area that is color of the skin by changing pigmentation as defense mechanisms. When man shivers due to winter his defense is to coil his head leg and hand in such a way that it should be least exposed and using body heat for warmth. When it was not sufficient to prevent cold he could have designed covering himself with dry grass, cotton quilts etc. to counter winter. 'Is it not design with surface area?'

Why does hot water come to room temperature faster if it is place in broad mouth container? Why do we design mouth of the bottle narrow? Is it because narrow surface area interfaces minimal with the environment so helping in maintaining the content at the same state for longer time? Is design of Kite not such that it floats against the wind direction and head of it is under the control of the user for creating desired movements? What is the function of detergent in extracting of dirt from the clothes? Answer is simple surface area since it is directly associated with surface tension. Have we ever given proper thought about role of surface area in design? It is natural thing given to us by divine power. When I look at the fumes, it reminds me act of vanishing of dark smokes by mingling with air. Is it not act of simplest design by divine power by increasing surface area of smoke? Eruption of volcano is natural and its lava comes out

with smoke. Smoke spread in the air and lost its form and lava becomes solid as it gets cold and spreads on the earth and does not remain hot and liquid what it was at the time of coming out. Earth quake is nothing but act of attempt of changing surface area by its own mechanism. It creates tremor on earth and sometime it is so powerful that it may give the impression that existence of human race may end. Rivers are flowing as these swells in there surface areas and create havoc through floods. A change of a sapling into a plant makes the person to understand the reason of growth of surface area. What does make the plant to grow and what are the reasons it fails or prevents to grow, is the cause of birth of agriculture science along with various disciplines.

How beautifully ancient man designed the natural phenomena for the benefits of mankind is admirable. He was aware smoke always moves upward and he designed chimney as well as developed the language among the group it could be used as signal when person is in trouble or distress. When someone is in emergency or lost his way in jungle or where chances of visit of man is rare and needs help, signal of smoke gives the message that someone is in trouble and rush for help whosoever is witnessing. This signal is equally good in night as well in day time. Fear of possibility of quake force the person to design the abode accordingly with inbuilt character of minimum damage to occupants. The character of flowing water helps the human to design the boat using the property of thrust. Better the design of surface area of boat better for the floating, movement & safety. Drying the vegetables in future use forced men to spread them on the ground exposed to sunlight. If they spread the fish for drying on the earth surface, they have realized bacteria of earth destroyed the dead fish faster than drying and it is no more fit for

human consumption. To tackle such problem they designed the vertical structures with local resources and it is generally made with bamboo like sticks tied with rope and dead fishes are tied with structure for hanging for drying under the sunlight. Fishes are away from the earth that eliminates the chances of spoil by bacteria and remain useful for human consumption.

In modern time we design variety of illuminations keeping the area in mind. It means we plan which surface area is to be illuminated. We cut the vegetables for even, fast cooking and in this attempt we increase the surface area and eliminate those portions that require different times of cooking. Why do we design various utensils for cooking? Surface area is different of various edible items. We need cutting, peeling, grinding, frying, and baking for cooking so we need different tools for efficient managements. A fryer or cooking utensils is designed with keeping in mind different surface areas. Is it concept of nonstick cookware not based on design of surface area? Rail tracks are designed keeping in mind when two metals are interacting friction force comes into actions and heat is natural byproduct. Heat expands the metal so we need gap at the time of coupling of two rail tracks. If we don't do make the provision it may invite accident. A carpenter uses variety of tools to shape the area as per requirement. It means man had been long aware about importance of surface area in design and he so designed filing, cutting tools and abrasive papers. Is design of the pair of shoes not technique to interface of all types of terrains with minimal interface of surface design? Design of pesticides management is based on sprinkle or spread with pump that changes liquid into spray. It is an act of increasing surface area. Is not compression an act of surface design? We use various elastic to use the property of surface area

for achieving our goals. Is design of parachute not design with surface area? When we design solar panel for absorbing maximum sunlight for conversion into electricity we use panel with maximum areas. Is design of spring or hydraulic not application of concept on surface area?

Most of the designers think much has been discussed and nothing is left unexplored. I say possibilities are everywhere and we need probing minds that should search possibilities from all angles. There is an incidence in recycled paper manufacturing unit where waste paper were stored in open ground and a small fire turned worth of millions of currencies into ashes. When I investigated the reason there was clear case of surface area and in no one could imagine that a small glass piece is the reason of sparking fire in paper. I found that while importing the waste papers from different countries somewhere a glass piece made its place among the paper. That glass piece accidentally might have exposed to sunlight and it turned into sharp pointed sunlight and generated such heat that was enough to generate fire in waste paper. This experience of surface design was different and ignoring a tiny glass piece cost heavy to the owner as well as insurance industry. In modern time, better compact design of automobiles has generated new problems due to surface area. The biggest challenge for automobile engineer is to manage the problems of surface area of engine by designing better parts or lubricants.

In daily life we use products that are designed with the concept of surface area. Tissue paper, diapers, sanitary napkins are designed with gel to absorb the liquid. Gel absorbs and increases its surface areas and helps in preventing of spilling of human waste. Roads surface area needs frictional force for applying brakes and it

demands different designing. Roads are slippery at the time of rain and high probability of accidents is noticed. Design of radial tyre is latest to encounter such problems by increasing the grip on the road and reducing somewhat chances of accidents by skidding .Similarly skates are designed with keeping surface area and property of ice in view. Cosmetics or paint industries are using surface area design to win the customer. Lipstick with different colors and shades with spreading and lasting are the winning points. Similarly with paint, how much it can spread and color the area is winning point. Why does woman use mascara or eyeliner? It is to appear virtual highlighting the surface area. Medical sciences are using implant material for surgery. There is technique to build the surface with resorbable blast media (RBM) for providing a macro/micro design with optimal surface roughness values and an increased surface area for osseointegration. Is design of medicine capsule not based on concept of surface design? Mobile companies are using a honey bee hexagonal design for coverage of entire population with the towers and it covers entire surface areas of the cities for better connectivity. Why washbasin or toilet seats are designed with ceramics with different surface design? Is it not it only gives desired surface areas for better operation? Cotton fiber with vast surface area is light and absorbent material and designer design the cotton wool for cleaning the wound. If we reduce the surface area of cotton fiber by twisting it has better strength as thread and can use for weaving clothes. Knitting, weaving and many associated fields have come to existence because of proper management of surface areas. Is design of stairs not with surface area? Is design of traction for the maximum frictional force that can be produced between surfaces without slipping not considering surface area? What is the basic

principle of Nanotechnology? Is it not surface area one of the prime area for Nanotechnology? For Wright brothers' biggest challenge was the management of surface area for achieving their goal? How are we to control the breeding of mosquitos in standing water reservoir? Use the property of oil that spreads over the exposed water surface area as thin film and does not allow passing oxygen for breeding to mosquitos. What is role of iron heating press to remove the wrinkles of the clothes? It is simply using heat on moist areas as it expands water evaporates with heat and clothes does not come back to previous shape and acquires a wrinkle free . Is it not surface area application? A sudden release of pressure increases the surface area and this phenomenon is known as adiabatic. This concept is used in designing engine as well as refrigeration. Explosion is not based on sudden increase of surface area?

Today's consumers are demanding quality packaging that is easy to use and that demonstrates the company is environmentally aware. Some corporations are working to keep material costs low and reduce their impact on the environment. This means that package designers have to find the balance between minimizing packaging materials and maximizing surface area. The birth of aerosol products is nothing but complying environment friendly philosophy. We never think about perfume or deodorant bottle is designed to increase the surface area. The relationship between volume and surface area is also critical in the design of bulk packaging and shipping containers. We generally take the help of knowledge of mathematics for calculating the surface area. Sphere, cylinder, cone and many more geometrical shapes has different surface areas.

We know that heat expands and when we take out it generally contracts. This theory is well use in medical sciences. When

someone is in pain medical practitioner advises application of hot water bottle in affected areas. It expands vein and clear the block blood or allow crack of muscles to expand and healing process expedite. In other case they also advice application of ice pack in affected area. It contracts and to maintain the body temperature body's blood rushes to affected areas and healing starts. Is it not application of surface area for treatment? Modern surgery is focusing on one area that is surface areas of skin and muscles should be damage as minimal possible for fast recovery. They are applying Laser beam or ultra sound technique for applying this philosophy. The surface area, which can be influenced by porosity, is an important property of a material in some applications such as catalysis, sorbents, pharmaceuticals and nanomaterial. The ability to measure surface area is hence extremely important in comparing and evaluating materials for these applications as it can influence their effectiveness and reactivity. Designer should know the latest scientific developments in the area of material science as well in process that will help in designing better products.

When child grows its surface area keeps on changing and we witness growth. We design stylish dress with such materials that should not last for years because life of the dress is short and child dress may not fit after a few months. On the other hand , as we grow and I am getting old and it appears to me that my body is shrinking and those dresses were not fitting me few years back is fitting by body and now I can wear. At last my coat will remain hanging in the wardrobe as it is and my body surface area will shrink to that level that my existence is no more in physical and my remains will go to ashes.

We are grateful to Prof Lalita Sen of Texas University for referring Prof Dr. Kenneth Joh who was the first among few who has not only accepted our invitation but appreciated this idea of declaring year 2013 year of student designers. It is great honor for us that he has made our publication a true international and I feel like to stand and salute for making our publication pioneer in design communities.

"Look beneath the surface; let not the several quality of neither a thing nor its worth escape thee" Marcus Aurelius (Roman emperor, AD 121-180)

With regards

Dr. Sunil Bhatia

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Forthcoming issues

June 2013 Vol-8 No-6

Ms. Cathy Dalton is a final-year PhD candidate at the Cork Centre for Architectural Education, Cork, Ireland, where she is researching potential use of ambient technologies in residential environments for elderly people, as part of the NEMBES embedded technologies project. She held a NEMBES PhD scholarship from 2009 to 2012 and is a qualified architect, with experience in the design of healthcare buildings.



Tomás Maher is a Final Year Student in the BSc Architectural Technology course at the Cork Institute of Technology.

July 2013 Vol-8 No-7

Christian Guellerin is president of Cumulus, the International Association of Universities and Schools of Design, Art and Media since 2007. The organization counts 178 establishments in 44 countries. He is also the executive director of the Ecole de



design Nantes Atlantique, which trains professionals to create and innovate for socio-economic development, with an interface between technology, economics, and the sciences. Today they're expanding to China and India. He writes on design and pedagogy. He will act as philosopher & guide for this special issue and students of different streams will participate in this special issue.

August 2013 Vol-8 No-8

Dr. Antika Sawadsri PhD in Architecture, Planning and Landscape University of Newcastle upon Tyne, UK. Lecturer, School of Interior-Architectural Design (2004-present) Faculty of Architecture King Mongkut's Institute of Technology Ladkrabang (KMITL) Thailand will supervise this special issue of student designers.



September 2013 Vol-8 No-9

"Inclusive Tourism: international perspectives, accessibility and inclusion in the Brazilian tourism" is topic suggested by Prof Regina Cohen Pro-Access Group - Federal University of Rio de Janeiro and she will be Guest Editor.



"Woman Designer year of 2014"

IMMA BONET Executive Patron of Design For All Foundation has accepted the invitation of Guest Editor for our inaugural issue of our declared new series for highlighting the contributions of women in social movements of Design For All/ Universal Design.



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Guest Editor:



Dr. Kenneth Joh is an Assistant Professor in the Department of Landscape Architecture and Urban Planning at Texas A&M University, Program Coordinator of the Graduate Certificate Program in Transportation Planning, and an Assistant Research Scientist at the Texas Transportation Institute.

GUEST EDITORIAL

This issue highlights empirical studies that focus on the relationship between transport and urban design, and the role of non-motorized modes of transport in the contemporary city. Planning for sustainable and healthy communities has become the dominant paradigm for architects and urban planners in the 21st century, with the promotion of active transport such as walking and bicycling, and discouraging automobile use. This is an especially important concern to address in newly industrializing countries such as India, which is experiencing a rapid rise in motorization rates.

Automobile transport is the dominant mode of transport for much of the developed and rapidly developing world. The United States is the most highly motorized country in the world, with almost 800 vehicles for every 1,000 persons in 2010. This is largely due to a legacy of pro-auto transport and land use policies in the U.S. for much of the 20th century, such as the Interstate Highway Act of 1956 which encouraged the development of automobile-oriented suburbs. As a result, almost one-half of all Americans live in suburbs today, and most of them are designed for car use and not for pedestrians or cyclists. The lack of alternative transport modes presents a significant burden for disadvantaged groups such as low income persons, the elderly, and the disabled, raising concerns about accessibility and social equity.

In recent years, there has been a convergence of support for sustainable and walkable communities from urban designers, transportation planners, environmentalists, and public health professionals. Some of the key tenets of the sustainable transport paradigm are the emphasis on accessibility over mobility,

multimodal transport modes, and recognizing the social and environmental costs of transport. There has been increasing interest in promoting more walking and cycling in communities, not only for environmental reasons but also to increase public health. For example in the U.S., the obesity epidemic has been linked with an auto-dependent lifestyle.

This issue showcases the professional works by master's students in the Landscape Architecture & Urban Planning Program at Texas A&M University. Texas A&M University (TAMU) is one of the leading research institutions in the U.S., and the oldest university in Texas, founded in 1876. Located in College Station, it is in the heart of the Texas Triangle, a rapidly growing megaregion of approximately 15 million people which includes larger cities such as Dallas, Houston, and San Antonio. TAMU is the largest university in Texas and the 7th largest university in the U.S., with over 53,000 students. It is one of the top 20 research institutions in the U.S. in terms of funding and has made notable contributions to many fields.

The urban planning program at Texas A&M has a strong transportation focus, given TAMU's affiliation with the highly renowned Texas A&M Transportation Institute, which is the largest transportation research agency in the U.S. TAMU's planning program is also unique for its Certificate Program in Transportation Planning, which provides students with a substantive base of knowledge necessary to be a successful transport and urban planner. As the coordinator of the certificate program and a faculty member in transport planning, I have taught and advised dozens of students during my tenure at Texas A&M.

This issue examines multiple dimensions of sustainable transport focusing on non-motorized transport from four of my top students. The first article by Allison Hyde is a case study of the integration of bike share and public transit in Denver, Colorado. The second article by Todd Hansen examines multimodal commuting and mode choice in Dallas County, Texas. The third article by Nair Barrios is a U.S.-Mexico comparative case study of pedestrian accessibility for school children. Finally, the fourth article by Yichi Liu is a bicycle study of Texas A&M University.



Dr. Kenneth Joh, Assistant Professor in the Department of Landscape Architecture and Urban Planning at Texas A&M University

About the Authors



Allison Hyde received her Master of Urban Planning degree from Texas A&M University in May 2013. Her work on the integration of bike share and light rail transit in Denver, Colorado, USA was inspired by an internship with the City of San Antonio, Texas, USA, where she helped plan an extension of bike share within the San Antonio Missions National Historical Park. Ms. Hyde is a proponent of cycling for transportation and seeks to help communities in the U.S. shift their auto usage to more active modes of transportation. An avid traveler, she hopes to make her first visit to India in the near future and thanks Design for All Institute of India for this opportunity to share her capstone work abroad.



Todd Hansen earned his Master of Urban Planning degree with a Certificate in Transportation Planning from Texas A&M University in May 2013. He was the winner of the Jesus "Chuy" Hinojosa Academic Excellence Award in Spring 2013. He participated as part of a team on the Texas A&M University Bike Share Feasibility Study. He has worked in transportation planning with the Brazos Valley Council of Governments and currently with the Transit Mobility Program at the Texas A&M Transportation Institute. He earned a Bachelor's of Business Administration in Management with a minor in History from Texas A&M University in May 2010.



Nair Barrios earned her Master of Urban and Planning degree with a Certificate in Transportation Planning from Texas A&M University in May 2013. She also has an architecture degree with an emphasis on urban design in Mexico. She is interested in multimodal transportation, transit and sustainable development. Ms. Barrios is the recipient of the AICP Outstanding Alumni Award 2013 for her alma mater from the American Planning Association. Currently President of the Association of Student Planners, she intends to go back to Latin America and work in alternative transportation planning.



Yichi Liu earned her Master of Urban Planning degree at Texas A&M University in May 2013, specializing in transportation planning. After receiving a bachelor's degree in Geographic Information Science from Zhejiang University in China, Ms. Liu moved to the United States to pursue graduate study. Her two-year study experience in the United States has given her numerous opportunities to learn different cultures and expanded her vision. She has strong interests in promoting non-motorized transportation and sustainable development, as well as using GIS tools for analysis.

Integration of Bike Share and Transit:

The relationship between Denver B-cycle and light rail transit in Denver, Colorado

ALLISON HYDE, Master of Urban Planning, Texas A&M University

Abstract – How cycling and transit have and can be integrated is gaining greater acknowledgement in research and in practice. Accommodating cycle-transit users at the origin or destination end of their trip using a public bike share system is a recent development of the last five years in North America but one which holds much potential for encouraging multimodal transportation over the use of single occupancy vehicles. This study considers whether bike share within walking distance of light rail transit has led to a greater improvement in transit ridership than at transit stations outside of walking distance to bike share. Denver Colorado, where bike share has been operational since April 2010 and a light rail system has been in service since 1994, serves as the study area. The available data does not prove bike share causes increased transit ridership, but a spatial analysis of the study area supports conclusions regarding the success of bike share stations in and outside of walking distance to light rail transit.

INTRODUCTION

Over the past decade, a growing base of research has identified three potential benefits of cycle-transit integration (Krizek & Stonebraker, 2010 & 2011). For one, the relationship solves the First and Final Mile problem by linking transit to final destinations, and in enlarging the catchment area around transit stations and stops, should logically lead to higher transit ridership. Additionally, it improves the efficiency of transit by reducing the importance of feeder bus service to trunk bus or rail lines. Importantly, it should increase the mode share of bicycling.

Proponents of public bike share systems tout them as being particularly well-suited for cycle-transit integration. When bike share is used to replace trips made by personal vehicles, it reduces greenhouse gas emissions and reliance on fossil fuels and deducts those vehicles from the roadway, reducing congestion. Each trip also provides an opportunity for the rider to be physically active while traveling to his or her destination. Supporters also often cite the natural propensity for bike share systems to link users with public transit.

Indeed, in surveys of bike share users, respondents report decreasing their automobile usage¹ since joining bike share (Capital Bikeshare, 2012, p. 45) or to have used bike share to connect to/from transit² (Duvall, 2012). Such self-reported behavior provides some evidence that there is indeed a connection between bike share and transit usage. However, studies looking particularly

¹ *Forty-one percent of respondents to a survey by Capital Bikeshare reported driving less since joining the bike share program.*

² *Of annual members of the Denver B-cycle system, 26.4% answered that they used bike share to connect to a light rail or bus stop.*

at bike share's influence on transit ridership are rare. This is, to the knowledge of the principal investigator, the first study that compares quantifiable usage of a bike share with quantifiable usage of a transit system.

Thus, this study poses the following question:

Does the availability of a public bike share system increase transit ridership by facilitating the Final Mile connection?

In using the phrase, "facilitating the Final Mile connection," it is meant that the availability of bike share has made taking public transit a viable commuting option for more people through providing a link between a transit station to a final destination that before the implementation of bike share would have left the transit station inaccessibly distant from the final destination. To understand this situation, this study focuses on the relationship between public bike share and light rail usage in the city of Denver, Colorado. The following hypothesis is made:

Light rail stations within walking distance of a Denver B-cycle station will have witnessed a rising level of ridership above that of stations not within walking distance of bike share.

One-quarter mile is considered as walking distance for this study, although one-half and one mile buffers are additionally mapped to give further perspective of the relative bike share and light rail stations distances.

STUDY AREA BACKGROUND

Denver, Colorado

In Denver, the percent of commutes made by bicycle has grown faster than it has nationally. In 2011, 2.4% of journeys to work in

Denver were by bicycle, placing the city sixth for this commute mode among the 44 U.S. cities with populations over 400,000 (U.S. Census ACS, 2012). Fig. 1 depicts the change in commute mode share for cycling and transit in Denver and the U.S. While rates for both modes remain quite stagnant on the national scale, capturing just a few percent more each across the six-year period, rates for cycling and transit for Denver reflect greater variance. From 2006 to 2010, they are inversely related. While the percent of commutes by cycle had been growing since 2008, the percent of commutes by transit was dropping, until both commute modes saw an increase in use between 2010 and 2011. The change seen since 2008 in bicycling has been substantial, growing 50% from 1.6% to 2.4%.

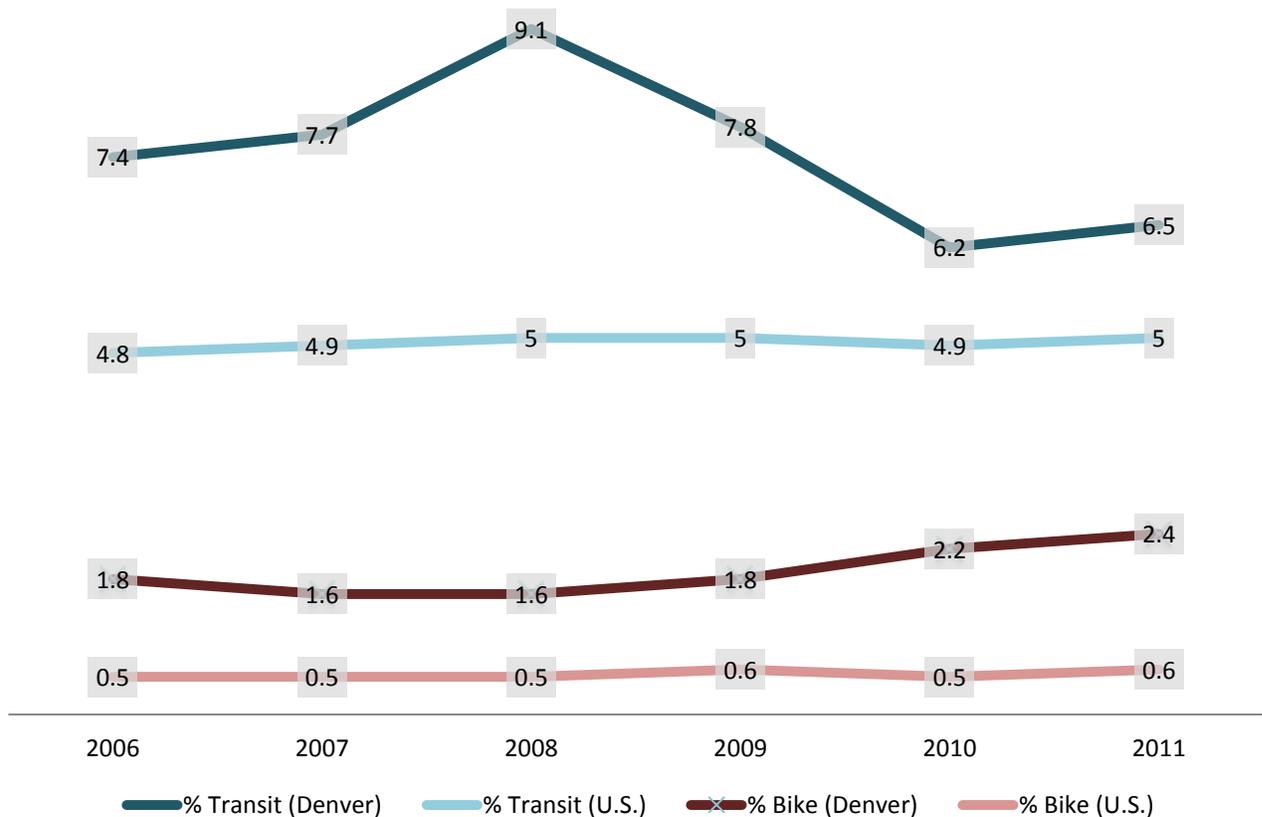


Figure 1 The mode share of commutes made by transit and bicycling in Denver, Colorado and the U.S. (Source: ACS 2006-2011)

Regional Transportation District of Denver

The Regional Transportation District (RTD) operates five light rail lines and 140 bus routes among other transportation services for eight counties within the Denver Metro Area. The city's light rail transit (LRT) system opened in 1994 and has been expanded three times since 2000. Its 35-mile service length and 35 stations³ attracted over 65,000 average weekday riders in Fourth Quarter 2012 (APTA, 2013, p. 3). A 12-mile extension of the LRT system from downtown Denver to the western suburb of Golden opened in April 2013. (For a current system map, visit rtd-denver.com.)

Denver Bike Sharing and Denver B-cycle

When its full-scale public bike share program, Denver B-cycle, launched on Earth Day, April 22, 2010, Denver became the first city in the U.S. to establish a bike share program (DBS, 2011, p. 9). Owned and operated by the 501(c)3 non-profit, Denver Bike Sharing (DBS), the system originally comprised 40 stations and 400 bikes but added 10 more stations within a few months of the launch, bringing its first year total to 50 stations. DBS cites seeking input from "bike advocates, city planners, traffic engineers, transportation planners, sustainability advocates, and a global public bike sharing scholar" as it planned Denver's system (2011, p. 9). Among the criteria that were deemed necessary for station locations⁴ was proximity to high use transit stops.

³ A 36th station, 29th & Welton, was closed in January 2013. As it was operational throughout the timeframe under analysis, though, it was still considered part of the RTD light rail system for this study.

⁴ Other factors DBS considered included whether locations served as both an origin and destination; density of the neighborhood; nearness to bike-friendly streets and trails; connectedness to employment centers, parks, and cultural and sport facilities; and station visibility.

The Denver B-cycle system closes for the winter in mid-December and opens again in mid-March. Over its second and third years in operation, the bike share system netted three additional stations, totaling 53 stations and 530 bikes by the end of 2012, although several stations had been closed or relocated throughout the timeframe (Burnap, 2012). The system operates within about a 12.5 square mile area, yielding an average station density of just over four stations per square mile (Toole, 2012, p. 58). Denver B-cycle began its fourth year of operation in March 2013 and is expected to open 27 additional stations funded by state and federal grants over the course of 2013 (Denver Post, 2012).

STUDY DESIGN

A pretest-posttest quasi-experimental design is employed to compare usage data before bike share was available in the Denver area (the pre-test timeframe) and after Denver B-cycle's launch (the post-test timeframe). All light rail stations are measured prior to receiving the "treatment" of bike share stations: B-cycle stations are collocated within one-quarter mile proximity, recognized as walking distance to transit, of 16 light rail stations. On the other hand, 20 light rail stations are further than one-quarter mile from the bike share system and deemed "untreated". Association, time order and alternative explanations are sought in order to establish causality between the presence of bike share stations and increased light rail station ridership. RTD and DBS provided usage data for this accomplishment to be attempted.

The availability of light rail ridership counts stipulated the organization of data and thus structure of analysis for this study. The RTD works on a calendar divided into three schedule

(“runboard”) periods. Boarding and alighting counts are registered for each station using Automatic Passenger Counters (APC), a passive infrared counter in the doorways of a sample fleet of light rail trains. The counts are averaged over the schedule period to produce a reliable estimate of weekday ridership at the station level that is also directional (north-bound or south-bound train) and reflects purpose of trip (boarding or alighting). The APC came into use during mid-2006 as extension of a 13-station Southeast line was underway. With its completion in November 2006, the light rail system increased to 36 stations. Due to the timing of the runboard periods, the first for which average weekday ridership counts of all stations were accounted was Winter 2007, spanning January 15 through May 4, 2007. This is thus the first “season” this study could consider for its pre-test dataset.

In considering the post-test dataset, it was necessary to take into account timing of Denver B-cycle’s launch on Thursday, April 22, 2010. As this falls near the end of the RDT’s Winter 2010 runboard, the first weekly checkout data to be considered in this study coincides with the RDT’s Summer 2010 runboard, which spanned May 2 through August 21, 2010⁵. Additionally, as B-cycle checkouts are reported weekly, pooling of the checkout reports into coinciding runboard periods was required to undertake comparative analysis.

⁵ *The RTD’s usage of “season” to describe their schedule (“runboard”) periods is an approximation of calendar-year seasons. While all 52 weeks are encompassed in the average weekday ridership counts, they are divided into three versus four seasons, Winter, Summer and Fall, lacking a Spring designation.*

In total, 10 runboard seasons, over three years of average weekly ridership counts, could make up the pre-test dataset. However, this

study considers just nine of these runboard seasons, Summer 2007

through Winter 2010, when interpreting light rail ridership data before the implementation of bike share in Denver. This allows for a more consistent comparison between pre- and post-test datasets. With Summer 2007 as the first season considered within the pre-test dataset and

Table 1 RTD seasons were grouped as shown below into three years of pre-test data and two years of post-test data that represent ridership trends before and after the launch of B-cycle in Denver.

Pre-test Year 1		
Summer 2007	Fall 2007	Winter 2008
Pre-test Year 2		
Summer 2008	Fall 2008	Winter 2009
Pre-test Year 3		
Summer 2009	Fall 2009	Winter 2010
Post-test Year 1		
Summer 2010	Fall 2010	Winter 2011
Post -test Year 2		
Summer 2011	Fall 2011	Winter 2012

Summer 2010 the first season considered within the post-test dataset, change in light rail ridership before and after B-cycle may be analogously compared between summer and winter seasons. In the Data Interpretation section, it will become clear why the seasonality of light rail ridership supports this organizational decision. To conclude, the pre-test dataset includes three full years of average weekly ridership counts for interpretation (Summer 2007 through Winter 2010), while the post-test dataset is composed of

the following two full years (Summer 2010 through Winter 2012), outlined in Table 1.

DATA INTERPRETATION

Analysis of System-Wide Usage

At the end of the 2012 calendar year, DBS was operating 53 B-cycle stations. However, over the life of the system, an additional three stations that once were active have been closed, and checkouts for all 56 total locations have been cataloged throughout the three years Denver B-cycle has been in operation. Although checkout data encompassing the total time span of this analysis is not available for each B-cycle station, every station is considered in the analysis where possible.

Fig. 2 depicts system-wide weekly checkout counts for B-cycle during its first three years in operation, 2010-2012. The number of checkouts has trended upward, reaching new usage highs each successive year.

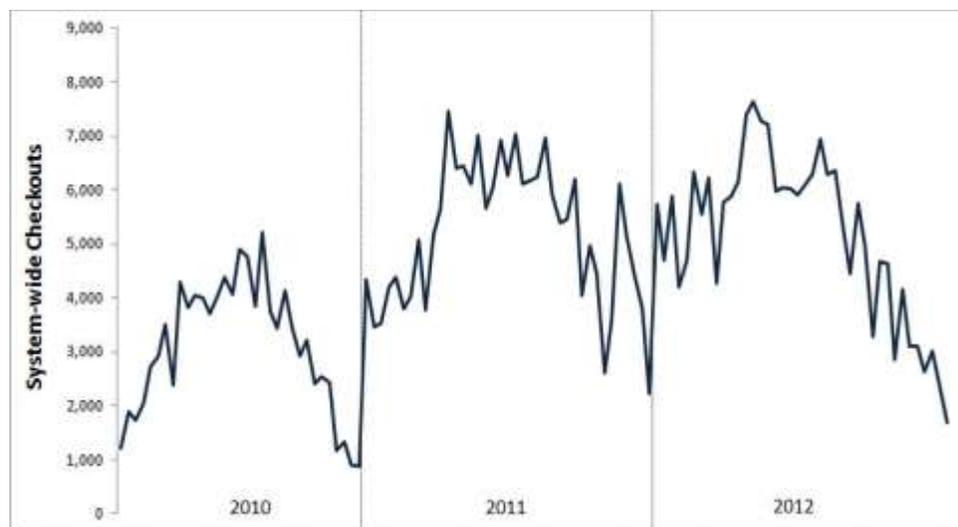
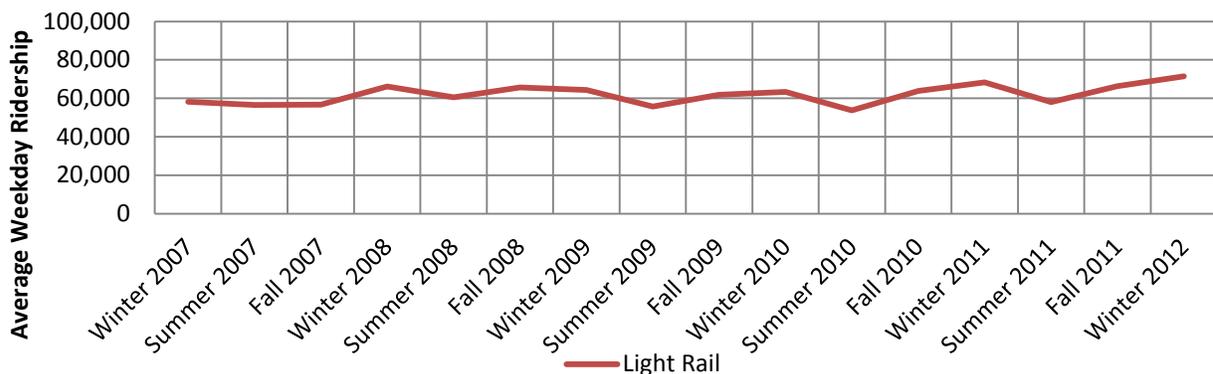


Figure 2 Weekly checkouts for the B-cycle Denver system over the first three years of its operation, 2010-2012. Compiled from checkout data provided by DBS.

While system usage is rising overall, whether that growth is consistent among stations will be considered in a spatial analysis below. When checkouts are observed at the individual station-level instead of at the aggregate system-level, it becomes evident, though, that proximity to light rail is not an all-purpose predictor for bike share station popularity. While the 10 bike share stations with the most checkouts each year were consistently found within one mile or less of a light rail station, most of the 10 stations in operation that ranked the least popular were also within this distance.

As mentioned in the previous section on Study Design, the timeframe used for calculations of growth and decline impacts our understanding of overall ridership trends due to this seasonality. Comparing annual growth that occurs within the calendar year versus year-to-year growth that occurs over successive seasons results in numbers of differing magnitudes, represented in Fig. 3. For instance, the light rail system’s percent change in ridership over three winters, winter 2007 through Winter 2010, a pre-test time frame, is 9%. This rises to 15% if pre-test ridership change is calculated as the percent change



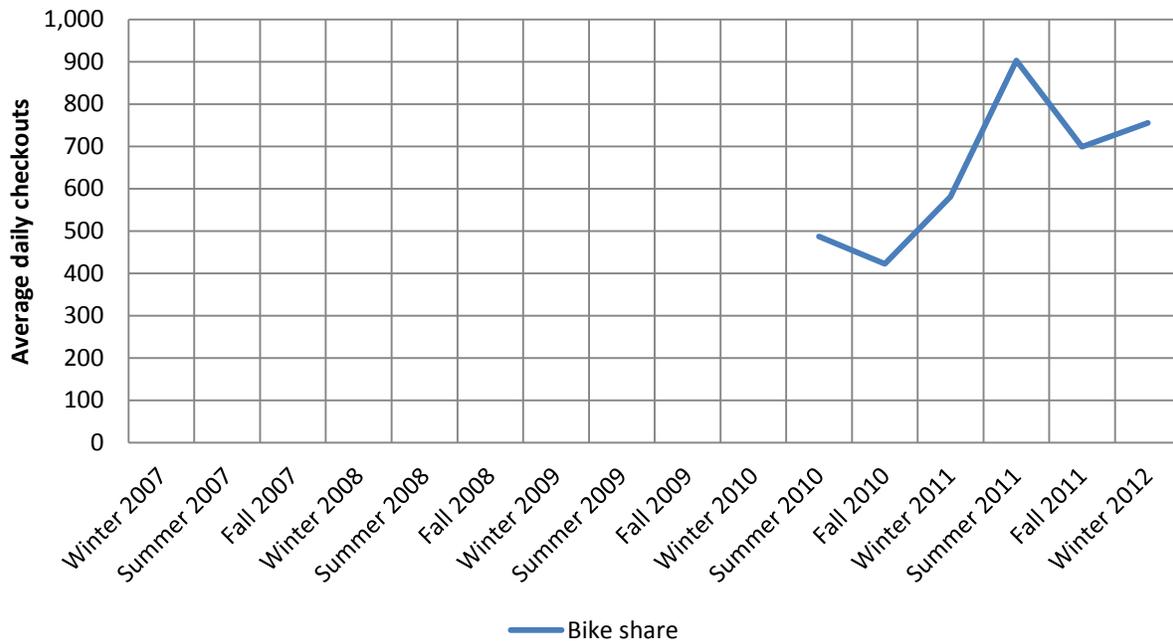


Figure 3 (top) Seasonal average weekday ridership for RTD Denver light rail and (bottom) average daily checkouts for B-cycle from Winter 2007 through Winter 2012. Compiled from data provided by the Regional Transportation District and Denver Bike Sharing.

between Summer 2007 and Winter 2010 ridership levels due to the summertime’s traditionally lower ridership level. It is a difference that affects what we perceive as normal, pre-test ridership growth. The launch of bike share in April 2010 places the first season of the post-test dataset at Summer 2010, necessitating the substantially lower ridership of the summer to figure into the percent-change calculation. It is best to likewise interpret pre-test ridership data using the same calendar year order, beginning with summer data and ending with winter data.

As Fig. 3 indicates, the summer with the lowest transit ridership counts during the study timeframe, pre- or post-test, was the Summer of 2010, just after the launch of bike share. However, the light rail system recovered well over the next two years, reaching its

highest ridership to date during Winter 2011 and topping that again in Winter 2012. Of additional interest is the negative correlation between the usage of bike share and light rail in the summer seasons. While light rail ridership is lowest during the summer, bike share usage is at its highest. Weather in Denver is most conducive for bicycling in the summer, likely accounting for bike share's higher summer usage. On the other hand, light rail usage declines in the summer, perhaps because students and employees are less likely to make regular commutes. While it is possible that bike share attracts a portion of LRT users away from rail and toward bike share during the summer, accounting for some of the loss in light rail boardings and gains in bike share checkouts, the ridership of light rail is vastly greater than bike share checkouts and impossible mathematically to account for the entire shift in ridership.

Thus, the dip of light rail ridership during the first season of the post-test timeframe and the opposing summer trends in modal usage together demonstrate that the magnitude of light rail boardings will overshadow any influences bike share may have on light rail ridership at the system-wide scale. To continue the study at a finer detail, a spatial analysis is performed at the level of individual light rail and bike share stations, visualizing stations by their percent changes in ridership.

It is necessary to analyze stations' growth or decline using percent change between the pre- and post-test study timeframes, as comparing average weekday ridership at face value is inadequate to detect *changed* change, While a station's ridership may grow throughout the study timeframe, the question of what is "expected" growth and what is growth that could be attributable to the nearby

presence of a bike share station would be unanswerable. The next sections explain the spatial analysis process.

Spatial Analysis: Pre-Test (Summer 2007 – Winter 2010)

The percent change of average weekday light rail ridership over the three-year, pre-test period (Summer 2007 - Winter 2010) was calculated for each light rail station. Table 2 depicts the distribution of data, of which the median percentage increase observed was 8%. Auraria West Campus Station is a potential outlier with a percent change in average weekday boardings during the timeframe of more than three standard deviations from the mean. Based on this spread of data across the light rail system, station-level ridership was reclassified by the percentile into which it fell.

Map 1 shows the spatial distribution of the light rail stations. Because the RTD operates transit for an eight-county area, some light rail stations are located outside the Denver city boundaries. As ridership data was available for all stations, these nine stations were still included in this study and, along with 11 other light rail stations beyond a one-quarter mile distance of the B-cycle network, serve as study controls, or the light rail stations that did not receive the “treatment” of a co-located bike share station.

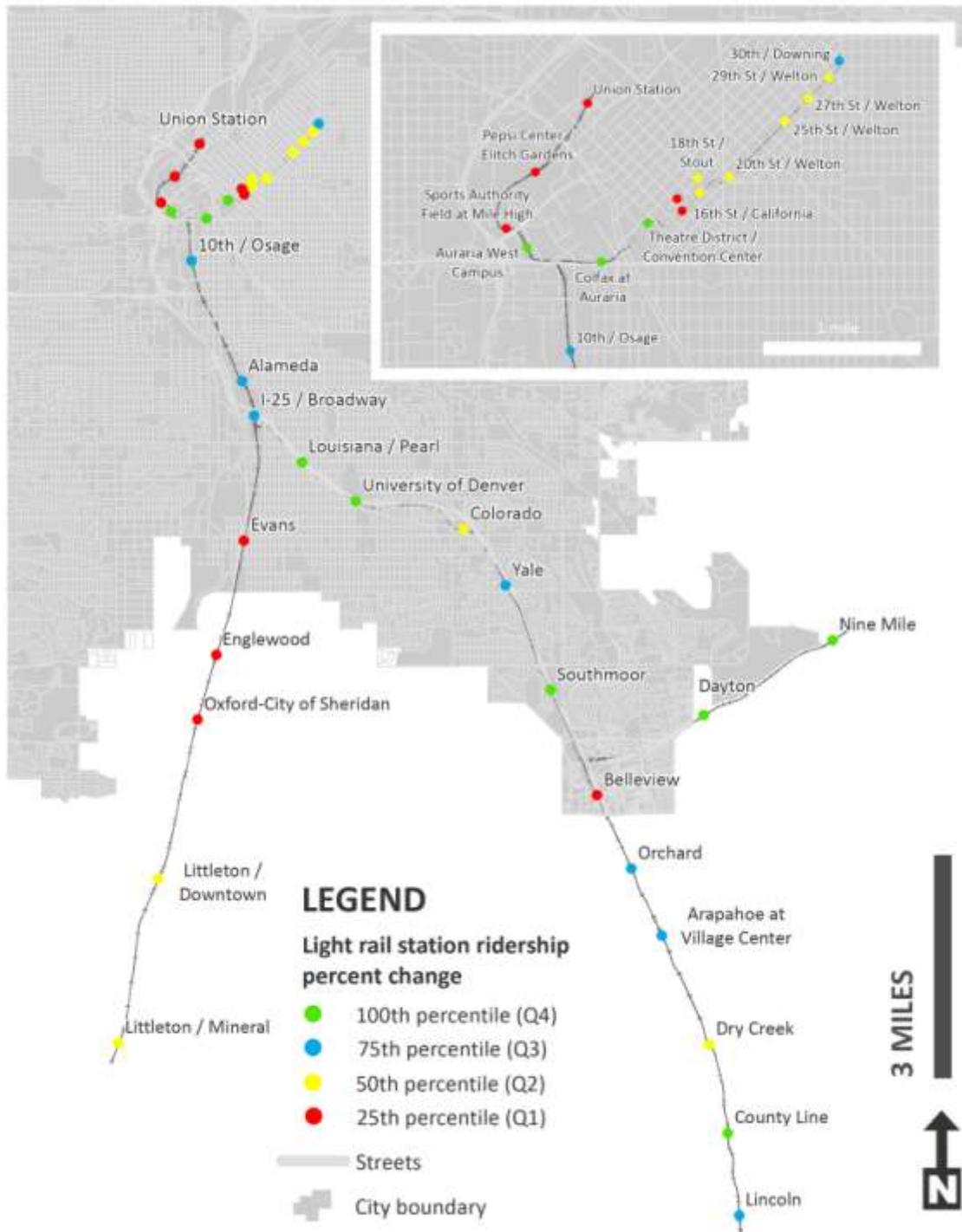
Table 2 Variability in pre-test average weekday light rail ridership

Mean	20
s	49
100% Max	183
75% Q3	23
50% Median	5
25% Q1	-8
0% Min	-48
IQR	31
Count	34

While the three end point stations of the suburban-reaching lines, Littleton/Mineral, Lincoln and Nine Mile Stations, experienced a percent change in ridership of varying degrees, high actual ridership was common for all three.

Among the cluster of 15 stations in the downtown core, nearly three-fourths fall into the bottom 50th percentile of ridership change between Summer 2007 and Winter 2010. The three stations in the downtown core where ridership level of improvement was within the 4th Quartile were Theatre District/Convention Center, Colfax at Auraria and Auraria West Campus Stations. Two are on Auraria Campus, which serves three institutes of higher education, including the University of Colorado Denver. Their ridership appears to follow an academic pattern, dipping in the summer but picking back up in the fall and remaining consistent through the winter seasons. However, in terms of actual ridership, the two stations differ vastly. Colfax at Auraria Station, often places 2nd among the Top 10 most popular light rail stations, and Auraria West Station has inched upwards from the very bottom position of ridership counts to a place in the upper Bottom 10.

A final observation of the pre-casual spatial analysis involves the four stations on Welton St. and one more on nearby Downing St. All the Welton Street Stations increased in ridership but at slow rates, placing them in the lower 50th percentile of ridership change as well as consistently in the lowest stations in terms of actual ridership. The station at 30th & Downing increased in ridership more substantially and performed above average in actual



Map 1 Pre-test average weekday ridership at each of 36 light rail stations is categorized by its level of decreasing or increasing change from Spring 2007 through Winter 2010, the three years preceding the existence of Denver B-cycle.

boarding counts. While the five stations service the D line only, 30th & Downing Station serves as an end station, which, like the end stations outside the Denver boundary, tended to attract higher boarding counts. While outside the timeframe of this study, it is worth mentioning that 29th & Welton is the only light rail station to have been closed, stopping service in January 2013 as part of an effort to maintain train efficiency and improve bus connections at neighboring 30th & Downing Station.

Spatial Analysis: Post-test of Bike Share's Effect on Light Rail Ridership

After spatially analyzing the pre-test change in ridership of light rail stations, the next step of analysis is to understand the effects bike share may have on light rail ridership based on geographic proximity and trends in bike share station usage. As was done for light rail stations, a percent change in usage from Summer 2010 to Winter 2012 was calculated for each B-cycle station. Eighteen stations opened after the initial launch or were relocated before the end of the second year. For 14 of these stations, percent change was calculated using the first or last full season for which the station was operational. A percent change could not be calculated for the remaining four stations, that opened during Fall 2011 or Winter 2012 because checkout data was only available for one (or less) full season.

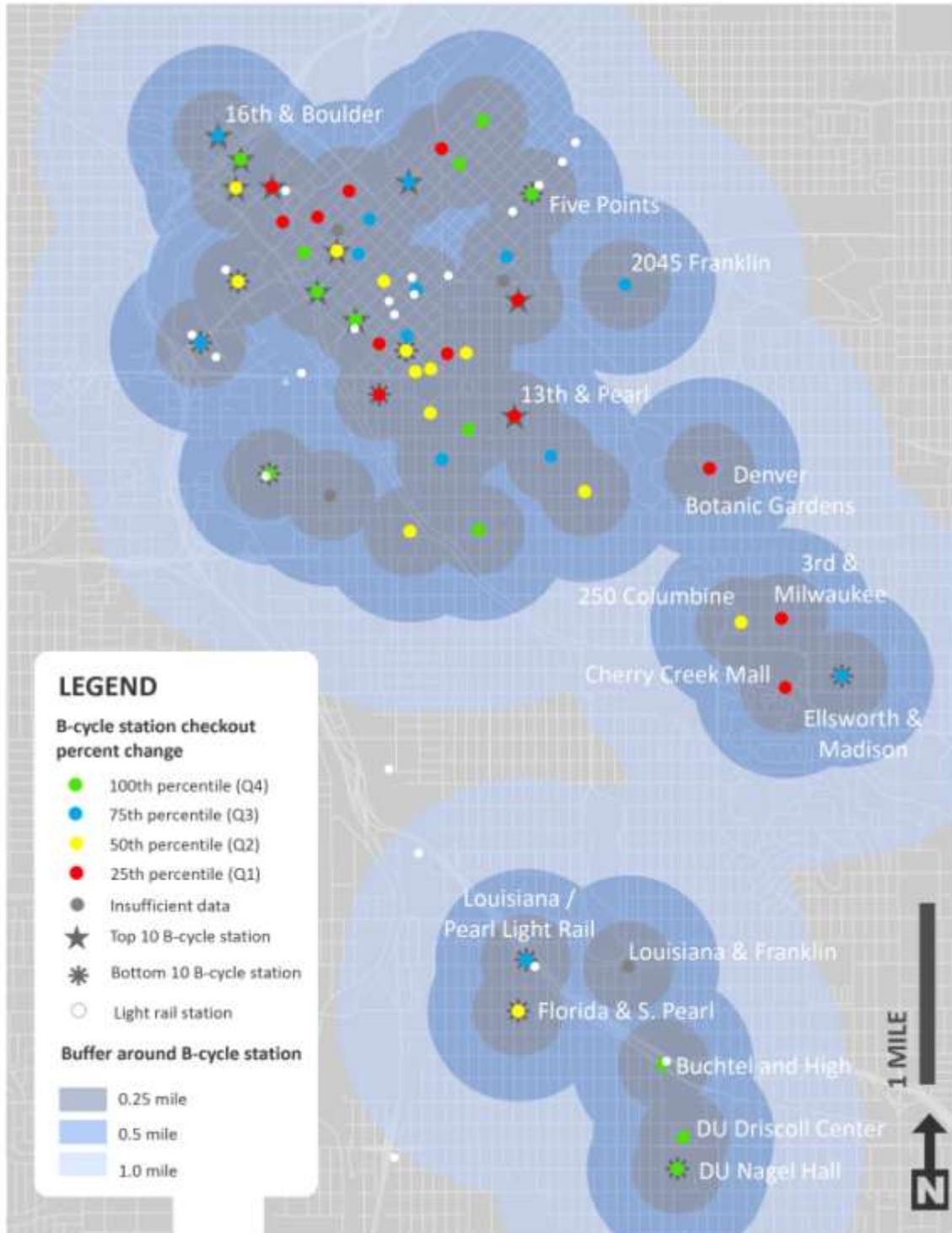
Furthermore, the calculation required that weekly checkouts pooled together into RTD light rail runboard season be normalized by days per season. When stations' weekly checkout reports were aggregated to coordinate with light rail runboard periods, the winter season of the B-cycle system, which is not operated during mid-December through mid-March, became much shorter than the summer or fall seasons. By normalizing checkout counts by days per season and working with this number akin to average daily checkout versus actual weekly counts, the inconsistent length of the seasons does not affect the percent-change measure of station performance.

Mean	49
s	49
100% Max	239
75% Q3	52
50% Median	34
25% Q1	19
0% Min	1
IQR	33
Count	52

Table 3 Variability in average daily checkouts

Table 3 shows the distribution of the bike share dataset, of which the median percentage increase observed was 34%. Buchtel & High Station, with a z-score of 3.9, is a potential outlier.

Map 2 aids our understanding of each station's change in checkouts in relation to others within the system from its launch through Winter 2012. The stations that consistently saw the highest and lowest number of annual checkouts over the three years of the system's operation are also designated. The map depicts, too, the relative distance of all bike share stations to light rail stations based on one-quarter, one-half and one mile radius buffers from the B-cycle stations.



Map 2. B-cycle stations are classified by their change in number of checkouts from Summer 2010 to Winter 2012. B-cycle stations that have consistently yielded the greatest or lowest numbers of checkouts throughout the system's three years in operation are noted as Top 10 or Bottom 10 performers, and a multi-ring buffer around B-cycle stations conveys relative distances from fixed rail transit.

Based on the hypothesis that ridership at light rail stations within walking distance of a bike share station will increase more markedly than that at light rail stations which are beyond walking distance of bike share, B-cycle stations are studied for their potential to support improved ridership levels at nearby light rail stations. It is suspected that Top 10-performing stations in particular are most likely to contribute to increasing light rail ridership. Using Map 2 to visualize stations' percent change of checkouts reveals four other scenarios of interest:

- **High-performing stations in the 100th percentile of checkout growth:**
 - **1350 Larimer grew 69%**
 - **14th & Champa grew 64%**
 - **16th & Platte grew 119%**
- **High-performing stations in the 25th percentile of checkout growth:**
 - **13th & Pearl Station grew only 1%**
 - **16th & Little Raven grew only 11%**
 - **19th & Pearl grew only 10%**
- **Low-performing stations in the 100th percentile of checkout growth:**
 - **10th & Osage grew 90%**
 - **DU Nagel Hall grew 139%**
 - **Five Points grew 52%**
- **Low-performing stations in the 25th percentile of checkout growth:**
 - **14th & Elati Station grew only by 1%**

Stations in the first and third categories that are within walking distance of LRT are expected to be associated with light rail ridership that increases more than expected based on the pre-test trend. Stations in the second and fourth categories that are within walking distance of an LRT station are expected to be associated with light rail ridership that increases a negligent amount or decreases based on pre-test trends.

Average daily checkouts nearly tripled for Buchtel & High, the B-cycle station near the University LRT station, from 3.5 per day to 12 per day. The two other B-cycle stations servicing the University of Denver campus, DU Driscoll Center and DU Nagel Hall (before being relocated in Winter 2012), also saw over 100% increases in checkouts. Checkouts at four more bike share stations, 1450 Wazee and 16th & Platte near the Union Station neighborhood as well as 7th & Grant and 12th & Sherman in the Capitol Hill neighborhood also increased over twofold during the study timeframe. Of the 13 stations that showed the most improved number of average daily checkouts (were in the 100th percentile) only four, of which one was the Buchtel & High location, were within one-quarter mile distance of one or more light rail stations.

DBS relocated three stations during the timeframe: from Union Station to 17th & Blake, from DU Nagel Hall to Louisiana & Franklin and from 15th & Tremont to 11th and Emerson. The B-cycle station at 11th & Emerson, installed in Summer 2011 replaced a bike share location that had been within one-quarter mile distance of the 18th Street light rail stations. The new location was over one mile from any light rail station, but by Winter 2012, the 11th & Emerson station

was attracting five times the number of checkouts that the station at 15th & Tremont had the prior winter.

Maps 3 and 4 serve our investigation into actual changes in light rail ridership. The percent change in average weekday ridership was again calculated for the post-test timeframe of Summer 2010 through Winter 2012. The distribution of the data is not as varied, demonstrated by the smaller IQR and range (see Table 4). Auraria West Campus Station, which has a z-score of 3.5, is again identified as a potential outlier station. As Map 1 illustrated the pre-test percent changes in average weekday light rail ridership, Map 3 demonstrates the post-test percent changes.

Assuming that, without the addition of the B-cycle bike share network, ridership at each station would have continued to grow or decline at the same rate it had during the pre-test timeframe, the difference in percent change each station experienced can be examined. Four possible outcomes are of interest:

- (a) Ridership increased more than expected at light rail stations within one-quarter mile distance of a B-cycle station,
- (b) Ridership increased less than expected or decreased at light rail stations within one-quarter mile distance of a B-cycle station
- (c) Ridership increased more than expected at light rail stations not within one-quarter mile distance of a B-cycle station, or

Table 4 Variability in post-test, average weekday ridership

Mean	32
s	33
100% Max	148
75% Q3	45
50% Median	27
25% Q1	19
0% Min	-19
IQR	26
Count	34

(d) Ridership increased less than expected or decreased at light rail stations not within one-quarter mile distance of a B-cycle station

Comparing the percent change in ridership over the pre-test timeframe to the percent change in ridership over the post-test timeframe, some stations improved ridership counts faster while growth of others remained steady or slowed. The change at each station is as follows:

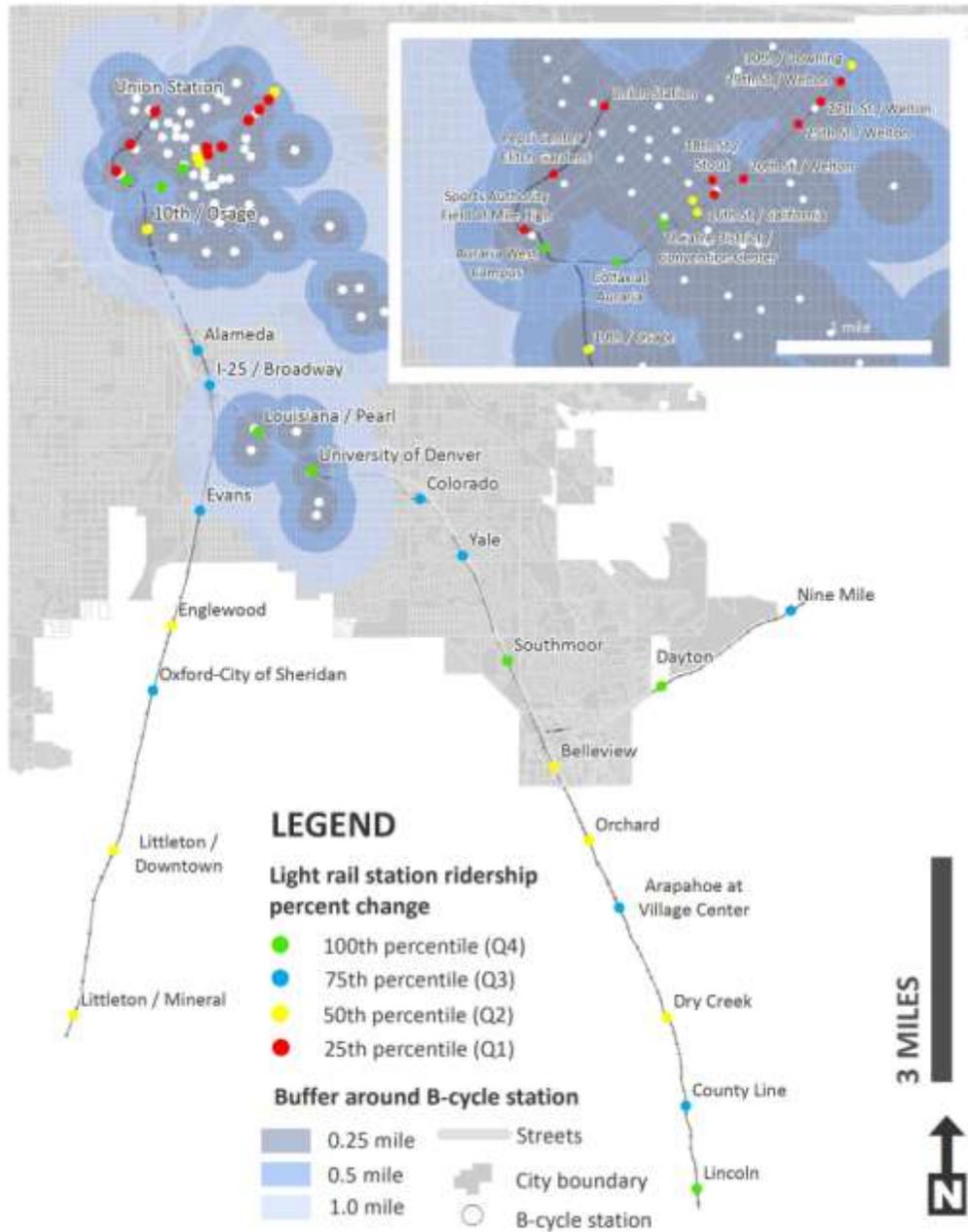
- **Light rail stations within one-quarter mile distance of a B-cycle station that saw ridership increase more than expected were:**
 - **16th St Stations**
 - **18th St Stations**
 - **20th St & Welton Station**
 - **Pepsi Center / Elitch Gardens Station**
 - **Sports Authority Field at Mile High Station**
 - **University of Denver**

- **Light rail stations within one-quarter mile distance of a B-cycle station that saw ridership increase less than expected or decrease were:**
 - **10th & Osage Station**
 - **27th St & Welton Station**
 - **Auraria West Campus Station**
 - **Louisiana & Pearl Station**
 - **Theatre District / Convention Center**

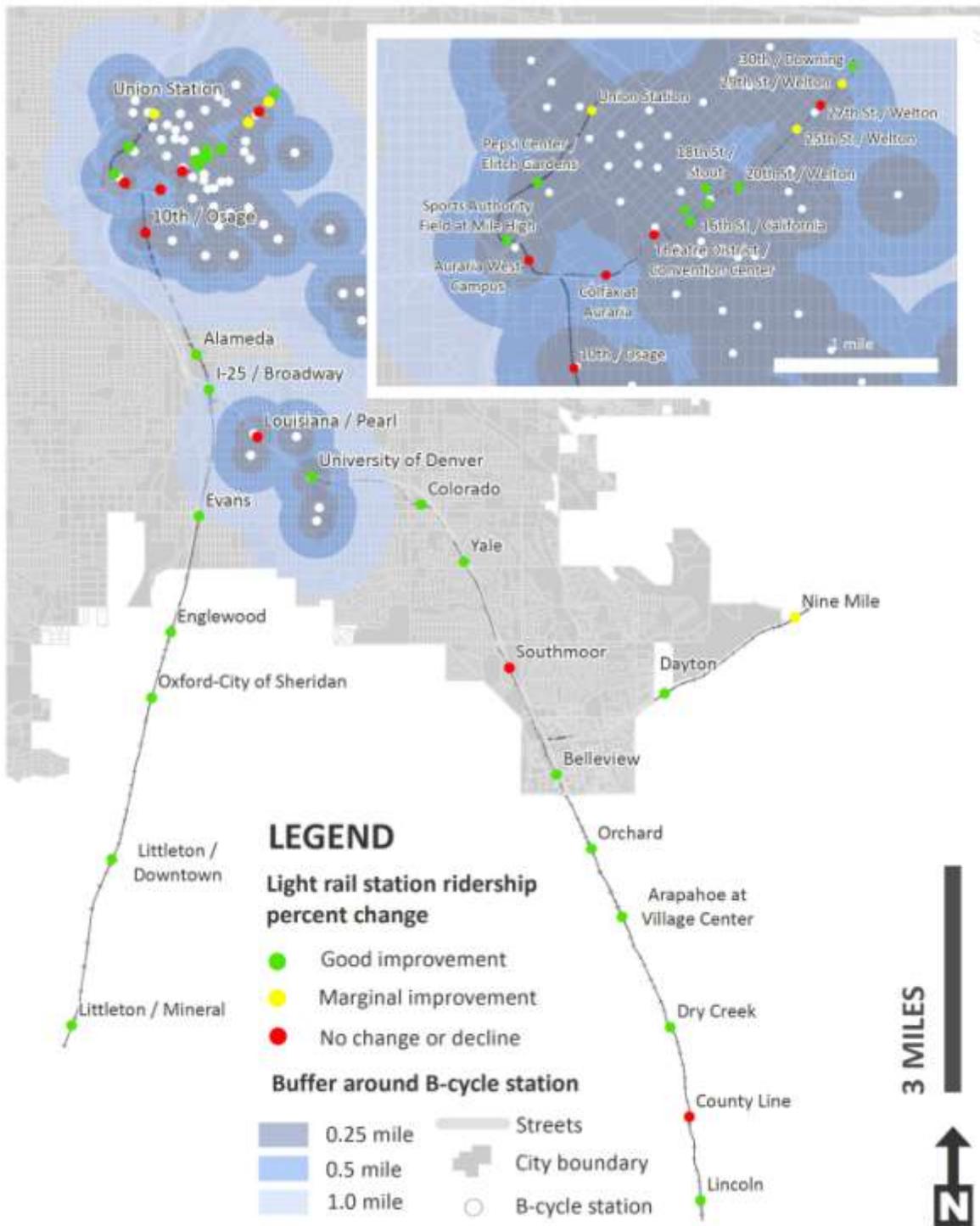
- **Light rail stations not within one-quarter mile distance of a B-cycle station that saw ridership increase more than expected were:**

- **30th & Downing Station**
 - **Alameda**
 - **Arapahoe at Village Center Station**
 - **Bellevue Station**
 - **Colorado Station**
 - **Dayton Station**
 - **Dry Creek**
 - **Englewood**
 - **Evans**
 - **I-25/Broadway Station**
 - **Littleton/ Downtown Station**
 - **Littleton / Mineral Station**
 - **Lincoln Station**
 - **Orchard Station**
 - **Oxford Station**
 - **Yale Station**
- **Light rail stations not within one-quarter mile distance of a B-cycle station that saw ridership increase less than expected or decrease were:**
 - **Colfax at Auraria Station**
 - **County Line Station**
 - **Southmoor Station**

Over half of the stations that are outside typical walking distance of a bike share station saw their ridership increase by at least 20%. It is possible that bike share played a role in these ridership gains, attracting new light rail users because of the final mile connection facilitated by bike share at their destination. However, the ridership gains are likely demonstrative of other factors beyond bike share contributing to increased average weekday ridership at these light rail stations. Increases in suburban population along these LRT lines, for instance, likely led to increased patronage of these stations.



Map 3 Post-test average weekday ridership at each of 36 light rail stations is categorized by its level of decreasing or increasing change from Spring 2010 through Winter 2012, the first two years of operation of Denver B-cycle.



Map 4 Light rail stations are depicted by the difference in the percent change in ridership measured during the pre- and post-test timeframes. A multi-ring buffer around B-cycle stations depicts their relative distance from light rail

One station that is within typical walking distance of a bike share station saw its changes in ridership from the pre- and post-test timeframes actually worsen. The percent change in ridership between Summer 2007 and Winter 2010 for 27th & Welton Station was 2% but this declined to a percent change of -10% in the post-test period. Within the timeframe under study, the station never achieved average weekday boardings over 468 (Winter 2008), although the closure of neighboring 30th & Welton Station in January 2013 may impact ridership in the future. The 27th & Welton LRT station is under a 300 ft network distance from the Five Points B-cycle station, a Bottom 10 performing bike share station but one that is in the fourth quartile for increasing checkouts.

DISCUSSION

As stated earlier, association, time order and alternative explanations are sought in order to establish causality between the location of bike share within walking distance of LRT stations and increase of ridership at those stations. The quasi-experimental nature of this study means the time order can be fixed; the proportion of light rail stations treated with the addition of bike share proximity is observed two years *after* the launch of B-cycle in Denver. The trend in percent change of ridership at LRT stations does not imply an association, however. While the 16 stations that did receive treatment (were within one-quarter mile of a B-cycle station) averaged a 7% improvement in boardings between the pre-test and post-test timeframes, the 20 stations that did not receive treatment (were not within one-quarter mile of a B-cycle station) improved more markedly (18%) over the duration of the study timeframe.

Thus, association between the treatment and increased ridership is not necessarily supported by the observed data. Alternative explanations are likely to impact the relationship further. Numerous variables, including the availability of parking spaces at LRT stations, gas prices, surrounding land use, or population and employment density, contribute to the functionality of particular light rail stations and the growth and decline of resultant ridership. A multiple regression analysis which could attempt to control for such variables was outside the scope of this study. While causality is not achievable with the current data set, spatial analysis of LRT and bike share station usage reveals two intriguing relationships.

Closest Bike Share Observation

Proximity within one-quarter mile distance of a light rail station does not guarantee a bike share station placement in the upper 50th percentile of usage growth. In almost every case where more than one bike share station shares the same one-quarter mile buffer from a light rail station, the closest bike share station to the LRT station showed more improved percent change and a higher number of checkouts.

Examples include the B-cycle station at 14th & Champa, which shares a one-quarter mile buffer from the Theatre District/Convention Center LRT Station with a B-cycle station at 14th & Welton. But, the B-cycle station at 14th & Champa happens to be half the distance from the LRT station of the B-cycle station at 14th & Welton. It grew in checkouts by 64% (vs. 16%) during the study timeframe and saw an average of 26 checkouts per day in Winter 2012 to 14th & Welton's 16 checkouts per day. Similarly, the B-cycle station at 18th & California, which shares a one-quarter mile buffer around the 18th

& California LRT station with B-cycle stations at 17th & Curtis and 1550 Glenarm but that is situated across the street from the LRT, outperforms both B-cycle stations in the number of checkouts and growth. While the B-cycle station at 1550 Glenarm, the closest station of five B-cycle stations within a one-quarter mile buffer of the 16th & California LRT station, does not perform as well as 14th & Champa or 18th & California B-cycle stations, both of these, as discussed, are primarily influenced by the LRT stations they are most directly situated beside. It does perform better than the two B-cycle stations it shares the buffer with but which are no closer to any other LRT station.

To further this concept, we can more closely examine the case of 11th & Emerson, the B-cycle station that was relocated from 15th & Tremont. As described above, the station previously at 15th & Tremont was within one-quarter mile distance of light rail, but it was not the closest B-cycle station to the 16th & California LRT station and thus had difficulty competing with other nearer B-cycle stations. When moved to 11th & Emerson, over a mile from the closest LRT station, competition was relieved, and the service instead was able to extend to an area where demand for bike share had previously existed unsatisfied. By Winter 2012, the 11th & Emerson station was attracting five times the number of checkouts that the station at 15th & Tremont had the prior winter.

The B-cycle station at 16th & Little Raven is an example where the closest B-cycle station did not produce the greatest percent change in checkouts. However, as it is consistently one of the most popular stations in terms of checkouts, its low percentage change is likely

due to it having reached a saturation point of accommodating checkouts.

Successful Neighbor Observation

As discussed above, location near a light rail station does not guarantee a successfully growing bike share station, but spatial analysis of the usage data shows that successful bike share stations often guarantee that another successful bike share station is located within a one-half mile distance. According to the FHWA's *State of the Practice and Guide to Implementation* for bike share, the standard station spacing of urban bike share programs is about one-half mile (2012, p. 18). Where the one-quarter mile buffers around bike share stations touch or overlap in Map 2, the distance between the bike share locations meets such a threshold. All but two bike share stations that ranked in the fourth quartile of checkout growth (symbolized in green in Map 2), were within one-half mile distance of another station that also placed in the upper quartile of checkout growth or of a Top 10 performing station.

Successful system usage requires that bike share stations for both picking up and dropping off be within convenient walking distance of a user's origin and activity destination. Such a pattern of usage is supported by the visual representation of percent change in checkouts at Denver B-cycle stations. As checkouts at particular stations grew during the post-test timeframe, growth in checkouts was necessitated at a station within reasonable cycling distance to accommodate the checking back in of such trips. It is not common, though, for a bike share station that ranked in the top quartile of growth to be the closest neighbor of another such station. The pod of stations on the University of Denver campus, near the University

LRT station, is an exception, presumably because the three stations served primarily as origins and destinations to each other and grew in parallel.

One of the two exceptions mentioned above is the 10th & Osage B-cycle station, which opened in Summer 2011 directly beside the LRT station at 10th & Osage. While it is relatively secluded from the rest of the bike share system, its extreme accessibility to the LRT station likely contributed to the improvement in checkouts it witnessed since then. The 9th & Santa Fe B-cycle station, 10th & Osage's closest bike share neighbor was not installed until Winter 2011, so users must have been attracted beyond a Final Mile from the Denver Health, 14th & Elati, or other distant bike share stations. While transit-cycle integration may have aided usage of the bike share station, the light rail station slipped from the 75th to 50th percentile of ridership change between the pre-test and post-test timeframe, meaning its ridership was growing since B-cycle was initiated, but not as strongly relative to the rest of the LRT system as it had been prior to treatment. Though growing, the bike share station at 10th & Osage simply did not attract enough daily checkouts to better influence weekday average light rail boardings.

Overall, the spatial analysis suggests a fine line exists between locating stations to accommodate convenient system linkage and saturation of an area occurring. The eight stations, from 14th & Welton east to 16th & Sherman and south to the Denver Public Library, exemplify possible system saturation. All eight place in the bottom 50th percentile in terms of percentage change in checkouts. While three, the Denver Public Library, 14th & Welton and 16th & Broadway saw at least 16 daily checkouts in the last season of the

post-test timeframe, four others ranged from five to 14 and were not growing. The last was 15th & Tremont, which was relocated and discussed previously. It appears that growing stations always have growing or Top 10-performing neighbors, but not all neighbors of growing stations will grow.

Recommendations

The data show that bike share stations within the same one-quarter mile Euclidean distance of a light rail station compete for cycle-transit trips. The closest bike share station to the light rail station often shows the highest increase in checkouts. While providing a dense network of stations conveniently accommodates overflow and increases the accessibility of the system to customers, the importance of extending access outward to a new area on the edge of the network may be more beneficial when competition near light rail transit facilities appears to decrease the productivity of bike share stations beyond the most convenient location. This demonstrates that a linkage between transit and bike share productivity exists, but it furthers the understanding of bike share and transit integration by exemplifying that walking distance proximity to transit is not enough of a reason to site a bike share station. When there is adequate station density, the most productive stations are situated very near or adjacent to transit access points, and it may actually disservice bike share stations to be located close but not close enough to a transit linkage.

Furthermore, bike share succeeds when well connected to other system locations. Light rail can be one factor of success, but if the bike share station itself is not integrated into the system, the station

will probably not serve cycle-transit riders well because there may be no attractive bike share station to cycle toward within a reasonable distance. When considering relocation of existing bike share stations, it is worthwhile to consider both percent change in checkouts in tandem with actual checkout counts. If a station is inhibited by the success of a growing neighbor near it, the bike share station may better serve users if relocated where it may extend the system one-half mile outward from a different successful bike share station. For instance, the B-cycle station at 14th & Elati may benefit from relocation next to the Colfax at Auraria light rail station if also within one-half mile of the growing, Top 10 performing B-cycle station at 14th & Champa.

Another recommendation to increase the effectiveness of cycle-transit integration is to make a concerted effort to streamline bike share membership and RTD transit passes, which would not only encourage the dual usage of the systems by easing the link between bike share and transit but would enhance data collection and interpretation of the cycle-transit relationship in Denver.

It is not state-of-the-practice within North America to offer combined-use discounts, let alone intermodal fare systems. No such “common bikesharing/transit card” has been issued in the U.S. or Canada which would require multiagency cooperation (Shaheen, Martin, Cohen, & Finson, 2012, p. 35). However, bikeshare in Hangzhou, China, the world’s largest system with over 60,600 bikes in use at over 2,400 stations, exemplifies such intermodal benefits (Shaheen, Zhang, Martin, & Guzman, 2011, p. 35). Under the same authority as that which runs the city’s bus, bus rapid transit (BRT) and metro rail, the Hangzhou Public Transport Corporation,

Hangzhou Public Bicycle bikesharing has been instilled in the public eye as a legitimate public transportation option. The inclusion of bikeshare under the umbrella of Hangzhou Public Transport Corporation greatly eases bikeshare-transit cooperation. With DBS and RTD being two separate operators, cooperation is encouraged to spearhead combined-use bike share-transit membership in North America that would incentivize residents to incorporate light rail, bus and bikeshare into multimodal commutes and help the city meet its goal to achieve a 15% bicycling and walking commute mode share by 2020 (City of Denver, 2011).

CONCLUSION

The benefits of better integrating cycling with transit – the First and Final Mile connection it resolves and thus the catchment area around transit facilities that it enlarges; the efficiency of the transit system it achieves through minimizing the need for transit feeder services; and the mode shift toward bicycling that it should prompt – make this relationship an exciting one to pursue in more depth.

While it is widely believed that bike share and transit are natural complements to one another, the research into this topic that exists is self-reported bike share user survey data or usage analysis of bike share stations in proximity to transit. However, no study as yet has analyzed pre- and post-test usage data of both transit and a bike share system. This paper has attempted to begin filling that gap by quantifying this relationship. Spatial organization of the usage data revealed the interesting observations that 1) successful bike share stations must neighbor another successful bike share station though not all neighbors will be successful, and 2) that being within walking-distance proximity from transit does not itself guarantee a

bike share station will grow in checkouts if other bike share stations are located even closer still.

While the spatial patterns revealed in the data still point to a linkage existing between bike share and transit, demonstrated particularly by the *Closest Bike Share* observation in the Discussion section, the hypothesis that ridership of light rail stations within walking distance of bike share stations would increase more so than that of light rail stations not within walking distance of bike share stations cannot be accepted. A comparison of the percent change in ridership before and after light rail stations received or did not receive treatment of bike share proximity revealed that those outside a one-quarter mile distance from bike share improved in ridership more substantially than those to which bike share was collocated.

Limitations and Potential for Further Study

As discussed in the section on Data Preparation, light rail transit ridership data is averaged by the RTD into three schedule (“runboard”) periods. Ridership data aggregated instead by week, comparable to the checkout data available for bike share, has the potential to improve this study. Variability in usage may be revealed at the finer weekly scale that here is perhaps hidden within the broadness of the seasonal context used for the percent change comparison. Additionally, the composition of timeframes used for the percent change calculation in this study may have skewed trends that could have been better reflected using timeframes composed of annual, consecutive seasons (Summer 2007 against Summer 2008, for instance, instead of Summer 2007 against Winter 2010).

Making this change in data preparation in combination with an analysis of more refined light rail ridership data, if obtainable, could yield an insightful future study of bike share and light rail usage in Denver, CO. If undertaken, multiple regression analysis or a difference in differences technique should be utilized to better understand the relationship between bike share and transit as it shifts on a weekly basis due perhaps to changing weather or gas prices or better accounting for the sociodemographic and land use characteristics of treated and untreated stations.

With more bike share systems being established in North America and those in operation continually maturing, the expansion in usage data that results should yield stronger datasets from which causality between bike share usage and improved transit ridership may eventually be proven.

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Multimodal Commuting and Choice in Dallas County, Texas

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Abstract – This paper focuses on commuting through multiple modes of transportation rather than the traditional automobile-only commute and analyzes it in a particular setting. Many American cities such as Dallas, TX grew up in the age of the automobile and are built almost exclusively for this mode. However, by increasing the amount of infrastructure for alternative modes of transportation, the accessibility of connection nodes between those modes, and the amount of mixed-use areas throughout zoned districts, the use of other modes of transportation such as cycling, transit, and even walking will increase as people look for other ways to get to work besides congested highways. The paper takes these lessons and applies them to Dallas County by looking at reported commuter trips, commuting mode choice sample data, and transit and bike route locations to identify correlations between the infrastructure and types of commutes to work. Following that will be an analysis of any correlations found and a description of policy recommendations for the area to consider to increasing alternative commuting mode share.

INTRODUCTION

Commuting is an every weekday activity which most Americans must go through, whether it is for five minutes or a few hours. How people get from their place of residence to their place of work is

heavily determined by what sort of transportation infrastructure is in place. The majority of the country's major cities, including Dallas, Texas, depend on our highway system to make this daily journey. Despite the high desire in public policy to reduce the number of drive-alone trips, there has been limited success in densely populated corridors. "While work travel is about 20% of total travel in the U.S., it remains important because of its absolute size and the predictability of travel times (Silver, 2012, p. 5)."

Commuting times and choices in cities can be greatly improved with more intermodal connections and higher service quality. Cities in the U.S. which have public transit systems and other alternative mode infrastructure in place are often able to compete with automobiles in terms of travel time. A 2006 study by Robert Cervero found that about 20 percent of Californians working in office buildings near rail stations commute by transit regularly, the point being that if workers have a choice they are likely to take advantage of it. Some people also choose their residence based on what travel options they have rather than figuring out their commute after the fact. Both land use and transportation have large implications for the travel behavior of commuters, and these two factors should be taken into account together when planning for the needs of people travelling to work.

This paper will look at the relationship between people's choices in travel modes, place of residence, and place of work, as well as examples of solutions which are being used to influence those choices. These traits will be examined through an in-depth analysis of Dallas County, Texas, including information about the area, highway and transit infrastructure, and commuter choice data. The case study will specifically identify any connections between the

kinds of commutes people in Dallas take and the locations of alternative facilities such as transit stations to see if these measures are affecting mode share for trips to work. Following will be a survey of methods and techniques that cities can use to increase intermodality and make an impact on the growing problem of highway congestion, including few specific case studies about intermodal commuting in different types of American cities. The results will show if providing better infrastructure and service will increase the willingness and likelihood of commuters to switch from private automobile-exclusive commuting to integrating other transportation modes into their commute in a specific setting.

CASE STUDY

Dallas County is one of the most urbanized counties in the state of Texas as well as the country, with a population of 2,368,139 in 2010 (U.S. Census). Its largest cities include Dallas, the county seat, Irving, Richardson, Carrollton, and Addison. Like many southern cities in the United States, Dallas exploded in population during the 1960s as people and companies began to move from the northeast more frequently, jumping from 434,462 people in 1950 to 679,684 ten years later, 844,401 in 1970, and today has reached 1,197,816 people in 2010 (U.S. Census). Meanwhile growth in the suburban communities around it also grew dramatically during this time period, as cheaper home prices and better school districts enticed people away from the central city. With very little in the way of geographic barriers to contain growth or concentrate densities, the character of Dallas County as well as the D/FW Metroplex has become very suburban-focused and reliant on longer commutes to get to job centers.

This pattern of population movement away from central business districts is not an uncommon occurrence in the United States. What does put Dallas in a particular group of large urban areas is how the region grew in population for many years without any kind of substantial transportation infrastructure. In the early twentieth century the Dallas area did have operating streetcar lines, but they were abandoned by 1956 (Cumbie, 2010). This made the Dallas area especially auto-reliant, and highways represented the sole points to access for people traveling between home and work. The major highways in Dallas County include Interstate 20, Interstate 30, and State 183, which run East to West, Interstate 45, Interstate 35, and State 75, which run North to South, and Interstate Loop 635, which goes around most of the county (Figure 1: Dallas Highways). The construction of these highways have allowed for populations to spread out in all directions by providing greater mobility than realized before. Today they also are the source of massive gridlock during peak driving hours as workers try to travel to and from Downtown Dallas.

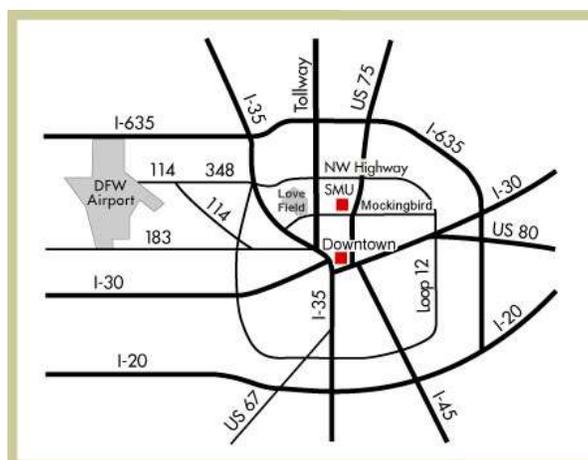


Figure 1: Dallas Highways

Demographically Dallas County exhibits the kind of diversity that is expected from a major urban area. The 2011 estimates found in the

American Community Survey set the racial breakdown at 69.3 percent White, 22.5 percent Black, 1.2 percent American Indian, 5.3 percent Asian, and .1 percent Native American and Other Pacific Islander. The ethnic background split for the county is 38.9 percent Hispanic or Latino Origin and 32.8 percent non-Hispanic White. The median household income estimate in 2011 was \$48,942, while the poverty level was measured at 18.3 percent. From these statistics it can be seen that Dallas has a wide array of people living in and around it. Like many areas of Texas and the Southwest there is a high Hispanic population in the area, and it has a higher black population than the state average. These statistics along with the poverty level indicate that there are traditionally transit-dependent populations in the region.

The American Community Survey also has estimates for the amount of time people spend going to work during a typical commute for 2011. This data is broken down into ranges in time, usually on the order of five minute increments. Only 9.3 percent has a travel time to work of 10 minutes or less, 12.6 percent travels 10 to 14 minutes, 15.6 percent travels 15 to 19 minutes, 15.7 percent travels 20 to 24 minutes, and 6.6 percent travels 25 to 29 minutes. For time ranges of a half hour or more, 18.8 percent travels 30 to 34 minutes, 6.6 percent travels 35 to 44 minutes, 8.3 percent travels 45 to 59 minutes, and 6.4 percent travels 60 or more minutes each day. According to this data about half of commuters in Dallas County travel between 10 and 29 minutes to work for a typical trip. However, the mean travel time for this data is 25.7 minutes, meaning that the average commute is closer to half an hour.

Commuting to work data about transportation mode used to get work for 2011 ACS estimates shows that Dallas leans towards

automobile use heavily. For the sample of workers who are aged 16 and over, 79.3 percent drive alone to work and 11.4 percent commute by carpool, meaning 9 out of 10 workers can be expected to use a car in some fashion for this trip. The percentages for other modes are 2.9 percent for public transportation, 1.5 percent for walking, 1.4 percent for other means, and 3.5 percent for working at home. While the automobile can be expected to be the dominate travel mode for any American city, the Dallas region is certainly not an exception.

DART

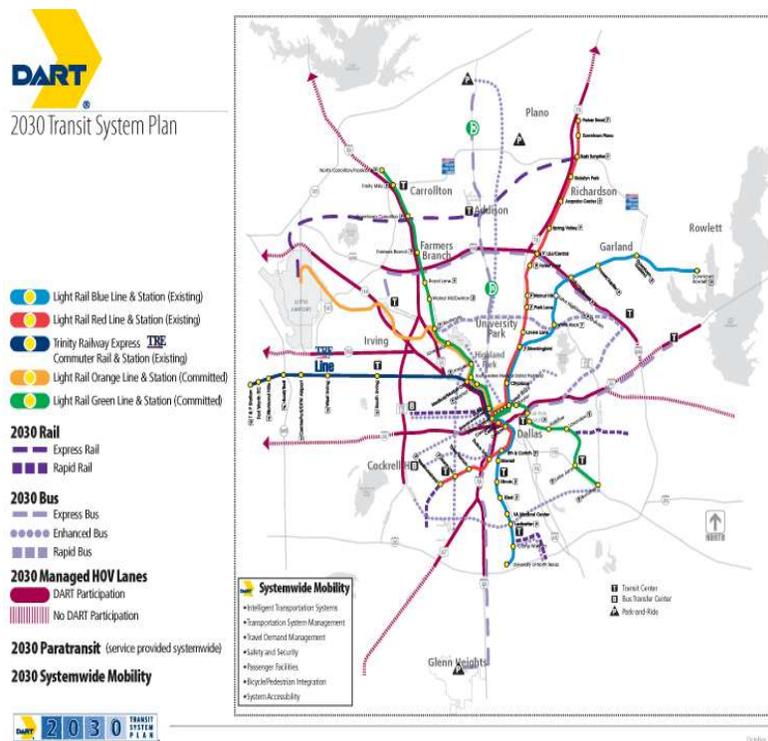
The modern major transit provider for most of the areas in Dallas County is Dallas Area Rapid Transit (DART). Dallas Area Rapid Transit became an official entity on August 13, 1983 with the approval from voters from 14 cities in Dallas County. Early on DART's priority was the creation of bus and HOV lanes (Wansbeek, 2007), but as early as 1984 DART decided that light rail would be its preferred form of transit for the future, with hopes of creating a 147-mile network. In January 1987, DART scaled down their expectations slightly, projecting that they could build a 97-mile network with the use of long-term bonds. The first light rail construction began in October 1990, and around that time DART published a five year plan wanting to shift bus service away from Downtown Dallas to a grid network in the county. The Red and Blue Lines opened in 1996, and have been extended further outwards in years following (DART, 2013). The Red Line starts at the Westmoreland station in the Oak Cliff area and extends upward into Collin County to its northern terminus at Parker Road station in Plano. The Blue Line begins at Ledbetter station in Oak Cliff and ends

at Downtown Rowlett eastward of Dallas. There are also two planned extensions for the Blue Line, Camp Wisdom Station and University of North Texas at Dallas Station, which are to be open by 2018 and extend the route even further southward.

The two newer light rail lines DART has constructed are the Green Line and the Orange Line. The Green Line, which was completed in 2010, begins at Buckner station in southeast Dallas and ends at the North Carrollton/Frankford station northeast of Dallas just over the county line into Denton County. The Orange Line is still being extended to its fully planned route but is currently operating at full service on already completed segments. It begins at the same northern terminus as the Red Line's Parker Road station and temporarily ends at the Belt Line station in Irving west of Dallas. The new western terminus of the Orange Line will be the DFW Airport Station, planned to open in December 2014, serving as the first rail connection between the major airport and Downtown Dallas. There are also a few deferred stations along the Orange Line in the Irving and Las Colinas areas which have begun construction but halted until more development in the area warrants service to them.

All four of the light rail lines go through Downtown Dallas and share four stations (Pearl/Arts District, St. Paul, Akard, and West End) which occupy Pacific Street and Bryan Street. These connection points between the routes serve as key alighting and boarding points in the central business district, and many other stations are also shared between multiple lines. In total there are 60 stations currently opened and 85 miles of track mostly within Dallas County (DART). The Cotton Belt Rail Line is the only new route currently planned in the system's future. According to the DART 2030 Plan (DART, 2006) this line would begin at the Bush Turnpike station

shared by the Red and Orange Lines in Richardson, run westward through Addison, connect at the Downtown Carrollton station serving the Green Line, and end at the DFW Airport Station at the same terminus point as the Orange Line will be. The entire system can be seen in Figure 2. In addition to these light rail routes DART operates the Trinity Railway Express heavy rail line (connecting Dallas to Fort Worth), local and express bus routes, a system of high occupancy vehicle (HOV) lanes, and a small trolley service (DART).



Source: DART, 2006

Figure2: DART Future System Map

Dallas is traditionally known as an unfriendly city to bicyclists because of its lack of bike specific infrastructure and automobile-centricity. As noted earlier, any road that completely favors the automobile and does not have safe amenities for bicyclists will likely only be used by the most experienced cyclists and discourage more novice riders from attempting to use them. Recognizing this problem, in 2011 the City of Dallas along with a public input created

the Dallas Bike Plan, which puts forward a future vision for the city to foster this mode of travel and become a friendlier environment for bicycles (City of Dallas, 2011). The plan calls for the creation of a new bicycle network, the Dallas Bikeway System, of around 840 miles of on-street facilities and around 460 miles of off-street facilities for bicycles in the city, with funding and construction occurring in phases (City of Dallas, 2011). At the time the plan was adopted in June 2011, most of these facilities, particularly on-street, did not exist, and even in the years following very little progress has been made in constructing more of them. The most notable existing facilities used in this case study are the Katy Trail and White Rock Lake Park Loop, both of which are off-street bike trails which span great distances north of Downtown Dallas. While these trails are not as adequate as separated bike lanes for commuting purposes, it is possible to use them as a connecting path between home and work for people within their proximity. Until more facilities become available Dallas will continue to be a difficult city to commute by bicycle in.

Try Parking It

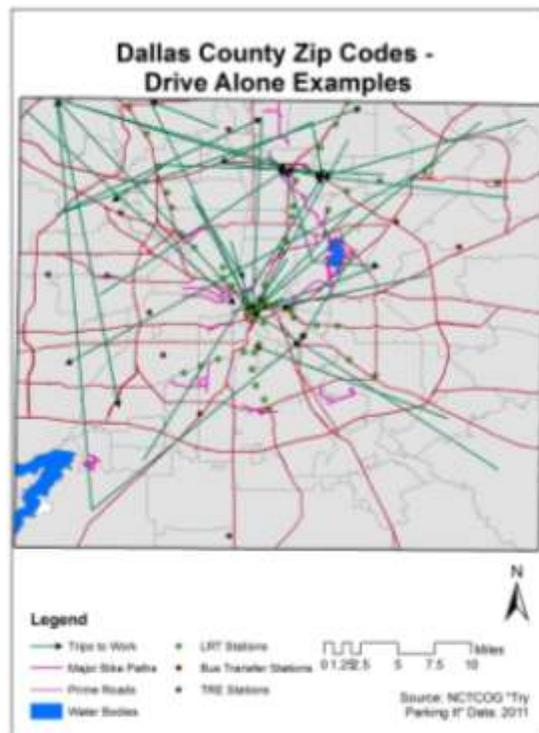
The North Central Texas Council of Governments (NCTCOG) is both the regional COG and municipal planning organization (MPO) for the Dallas/Fort Worth Metroplex. In addition to other focus areas some of the main work they do analyzes area transportation needs. One program they have started to both encourage alternative modes of commuting and analyze trip data is Try Parking It (www.tryparkingit.com). This volunteer program allows users to register on their website and enter in their daily commute trip information so that they can keep track of their miles travelled

through their profile. The goal of the website is to reduce the total number of commuter trips to work in order to improve the air quality in North Texas, and NCTCOG encourages users to take that goal into account along with the potential financial savings and health benefits they could gain by using alternative modes (NCTCOG).

NCTCOG also offers a ridematching service by connecting people through their registered profiles and transportation needs to place them in a carpool or vanpool. Users can log their trips as either riders or drivers for the operating carpool. The travel logs that are collected allow users to state whether their trip involved bicycle, carpool, driving alone, did not commute, telecommute, telework center, transit, vanpool, or walking. Some of these options do not involve a physical trip but are placeholders for miles that could have been travelled by the user on that date. The data from these logs has limitations in that it does not make up any legitimate scientific sample for analysis, because users are only volunteers rather than being randomly selected beforehand. However, it does provide a picture of the kinds of trips that commuters take as well as the origin and destination of them.

Looking at the reported work trips for 2011 that were just taken within Dallas County, meaning commutes which had both trip ends within a Dallas County zip code, there are patterns can be observed. One of the immediately noticeable trends is the end points, or work locations, of the commuter trips. Even as employers have more regularly shifted their location away from the city downtowns and towards suburban populations as made possible by expanded highway systems, the central business district still contains a massive amount of employment and accordingly receives those trips from the areas around it. This area in Dallas County is very close to

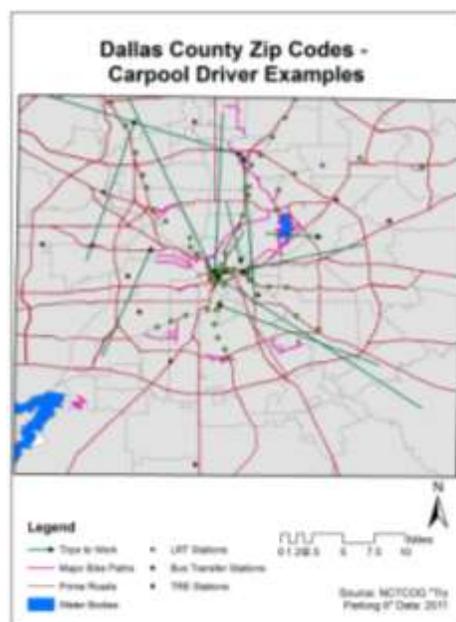
the geographic center of the political boundary, and in all of the commuting trip maps the CBD receives the visible majority of attention. On the other hand, another area where commuting trips frequently end is the corridor along Loop 635 well north of downtown Dallas. This is another major employment center in the county and an example of polycentric growth that has occurred in the area. A third general observation is where the commuting trips begin, with more reported trips originating in the northern half of the county where suburban development and population totals are higher. Because the trip data does not represent an accurate sample there cannot be many assumptions made from this due to information distributed about the Try Parking It initiative, possible volunteer bias, and trips going unreported. However, it can be expected that a greater number of trips would be reported from areas where more of the county population lives.



Source: NCTCOG

Figure 3: Drive Alone Trips

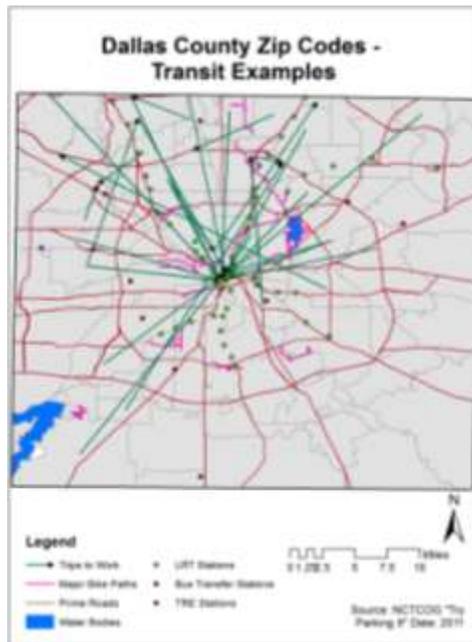
The first example to look at for this data is drive alone trips (Figure 3), which total to 1232 distinct records and originate from a wide range of the areas in Dallas County. This is not surprising, because the county has an interconnected web of highways which provides coverage to most of the places within it. With so many opportunities for residential development to occur within a few miles a major highway, automobile commuters can reasonably live anywhere within their means. Another observation from this set of data is how far the trips extend compared to the other modes of travel. Many of the trips span a distance of half the county's length or greater, some of them even going through the central business district (by Euclidean distance) to the other side. This does not even consider reported commuter trips which either come into Dallas County or originate in the county and end outside of it. These trips speak to the amount of mobility that automobiles and highways can provide for people who have the means or preference to choose it, as well as a reminder of how the automobile driving dominates the region.



Source: NCTCOG

Figure 4: Carpool Trips

There are far fewer examples of distinct carpool commuting trips (Figure 4) with 202 reported to NCTCOG in 2011, but this can be expected because driving alone is usually preferred by commuters who own cars over sharing a ride with others due to reasons of personal comfort. The data shows that most of the trips for carpool commuters end in the CBD, the largest concentration of employment in the area. For ridesharing to work for travelers, it usually requires that the people taking the vehicle both live in the same general area and work in areas within a reasonable distance of each other. While these places do not have to be the same neighborhood or employer, respectively, the closer they are to each other the better. The carpool trips reported can also span a wide length due the mobility of automobile travel, but none of the examples span across the CBD as seen with drive alone trips. A possible reason for this could be the difficulty of matching together residents with common work area destinations.



Source: NCTCOG

Figure 5: Public Transit Trips

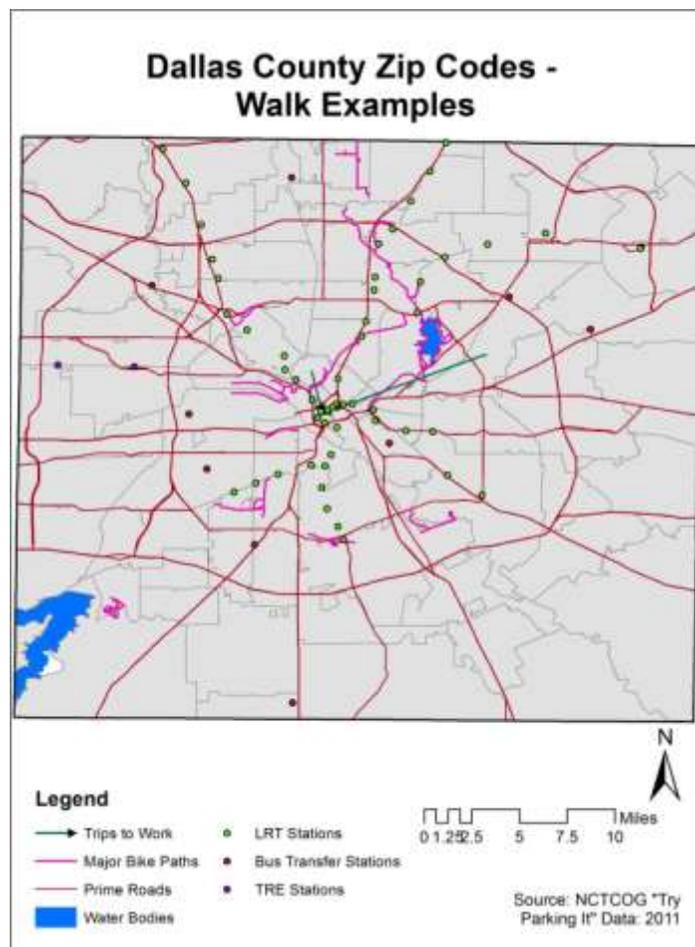
One of the most interesting subsets of this data is examples of commuting trips taking using public transit (Figure 5). As with commuting mode choice data from the American Community Survey, there is no breakup between trips made by rail and trips made by bus. However, the locations of light rail, heavy rail, and bus transfer stations can be compared against the rough trip ends of these commutes. Almost all of the trips, numbering at 1142, originate in the northern half of the county, which is not only where more of the population resides but also where the majority of DART's light rail stations are positioned. In fact, many of the trips reported seem to follow corridors where the Red, Blue, and Green Lines extend. While it cannot be assumed that these trips are being taken using light rail transit, the overlap is remarkable. Another observation is the direction of trips in comparison to rail station. Many of the commuting paths are focused inward towards the CBD, but some of them are actually headed in the opposite direction. This is indicative of where employment centers are located and how transit offers choices of accessibility in multiple directions, not just towards the central city.



Source: NCTCOG

Figure 6: Bicycle Trips

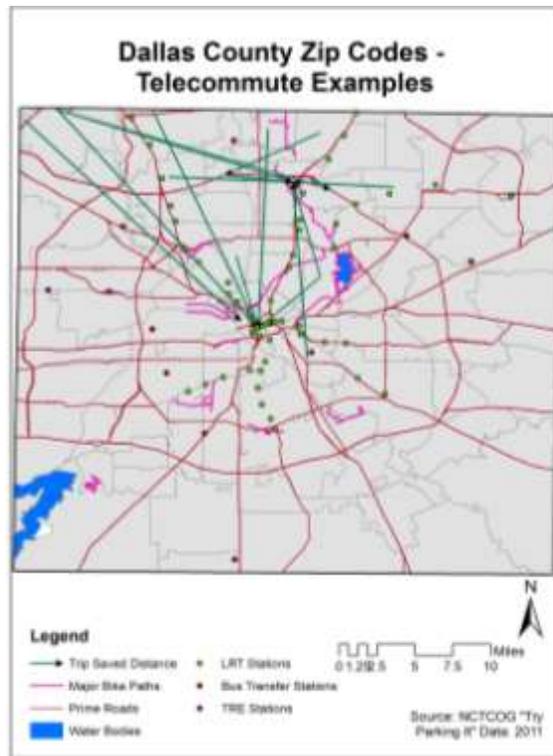
Despite Dallas not being oriented towards bicycle travel, there is a good amount of reported commutes, 761, by bicycle (Figure 6). There is a concentration of these examples in the area directly northeast of the CBD, where the majority of Dallas' bicycle infrastructure (the Katy Trail and White Rock Lake loop) has been placed so far. Even though these facilities are off-street bicycle paths rather than the preferred on-street buffered bike lanes, they offer a safe, connected route which cyclists can utilize. There are no reported bicycle commuting trips in the southern half of Dallas County, which could be because there is very little bicycle infrastructure leading to employment centers in that area.



Source: NCTCOG

Figure 7: Walking Trips

There are very few examples, 27 in all, of reported walking trips to work (Figure 7) for the year of 2011. In general people prefer not to walk longer distances than ¼ mile to get where they need to, and because of the way land uses are zoned it is often difficult to live within a comfortable walking distance to work. Given the nature of the Dallas area’s suburban growth it cannot be expected for many more walking trips to be reported in this data. The data collected for telecommuters in this initiative is particularly interesting because it is not measuring where commuting trips are occurring but rather where they would have occurred considering the volunteer’s residence and workplace locations. Many of these reported “trips”, totaling at 216, are longer in distance, showing why telecommuting can be advantageous for those normally needing to commute great distances, and all trip ends stop either in the CBD or along the 635 corridor, the major employment areas in Dallas County (Figure 8).



Source: NCTCOG

Figure 8: Telecommute Trips

METHODOLOGY

Multimodal commuting is rarely studied as a topic unto itself. Research done in this area usually compares commuting trips taken by driving alone against alternative forms of commuting, often discussing the connections between alternate modes of transportation but not about what they can mean to the entire trip. Similarly, there is no currently publicly available data about multimodal commuting trips in which to study this specific kind of travel behavior. However, the American Community Survey, which creates a strong representative sample of geographic areas to estimate yearly data figures, does have commuting mode choice data available for census tracts in the United States as recently as 2011. The variables in this data set include: population 16 and over, population in work force, population not in the work force, number of commuters, commuters who drive alone, commuters who carpool, commuters who use public transit, commuters who walk, commuters who use other means to get to work, and people who work at home. Also available is mean travel time to work for the census tract.

This data is not perfect for studying multimodal commuting behaviors because it divides the type of trip into strictly one mode of travel according to what the survey respondent answered, meaning the survey does not take multimodal transfers into account. The ACS specifically asks respondents to mark the method of transportation they use most during their typical commute. For example, if someone were to drive their car to a park-and-ride transit station and then ride a train to the central business district, their response for commuting choice would probably be recorded as only using public transportation. It also does not make a distinction between types of public transit used, meaning the respondent could be

referring to light rail, heavy rail, bus, trolley, or other transit options even though the specific kind is not accounted for. In addition, there is no respondent data for bicycle mode travel, and the only logical measurement for the commuting mode would be "other means to work". However, by comparing this sample data to its geographic locations and the locations of transportation features, we can look at a picture of the multimodal connections that could be taking place. Another limitation of this data is that it is only publically provided at the census tract level rather than a smaller geographic unit such as blocks or block groups. While these lower levels of geography would be more optimal, because they would provide more specific data points and in greater numbers, this is not as big of an issue in Dallas County, where the number of census tracts as of 2010 is 529. In a county with less density and more rural character they would be a fewer number of census tracts to study, and therefore this data would be much less useful.

The next step of the process involved the application of ArcGIS to look at this census tract data in better detail. TIGER shapefiles were downloaded from the census website for Dallas County, including census tracts, roads, and water features. Then, using both address information from the DART.org and satellite imagery on Google Earth, the locations of light rail transit stations, bus transfer centers, commuter train locations, and major bike trails were geocoded as point data. 5 Orange Line stations were not included in the analysis because they were opened well after April 2011 when the sample data applied. It is notable that while these kinds of transit centers feature different dominant modes, they all have either interaction between different modes of transportation and/or serve as meeting points for different routes in the DART system.

Additionally, the bike trails in the city were geocoded as polyline data by looking at existing facilities in the city from the Dallas Bike Plan and creating them as they were marked. Then the bike paths were intersected with Dallas County roads to create point data based on where streets and the paths met, or the access points to the paths. Separate shapefiles were made for each of these types of transfer points, but a master shapefile which included all four was also created by merging them together. The census tract data was joined to the corresponding census tracts, and then centroids for the tracts were created in order to transfer the data from polygon data to point data. The reason for this was to provide a level playing field when determining the distance between transfer points and census tracts. Using a centroid as the mean center of the census tract rather than using the nearest edge of the tract polygon allows for the average distance for commuters in census tracts to transfer points to be computed. The calculation was done by performing a spatial join between the centroids and the transfer points while computing the distance to the closest transfer point of that kind. The new shapefile includes this distance measure along with the American Community Survey data for the centroids.

Initially the process of looking at the numeric relationship between commuting mode choice and transit facilities was to be performed in ArcGIS alone, but limitations in the software arose. GIS is an excellent tool for displaying graphical information such as sums, percentages, and locations. It can also be useful for determining suitability based on locations, densities of variables, and certain aspects of correlation. One kind of correlation analysis tool is Moran's I, which determines spatial autocorrelation on a -1 to 1 scale. This kind of association is similar to the relationship between

choice and transfer points in that it computes a positive or negative relationship between the variables. The problem with using Moran's I in this case study is that the values it assigns are only for clustering of variables within the same feature class, not for comparing variables between two different kinds of features. Therefore, a different way of analyzing the commuter choice data was necessary.

Once all necessary shapefiles were created, their tables were exported out of ArcGIS as database files so that correlation could be determined. These database files were then manipulated using SPSS software. First new variables were created to determine the percentages of commuters using different modes of transit. This was done to create natural weights between the variables rather than pure commuter totals, which would skew the statistics in census tracts with higher commuting populations than others. The relationships between mode totals and commuter totals were mapped separately in ArcGIS using the normalization technique. Once the new variables were created and computed, the six different commuting percentages and the distances to nearest transfer points were entered into a bivariate Pearson's two-tailed correlation analysis, allowing each modes tendency to be affected by proximity to a transfer point to be measured.

RESULTS

The first type of transfer point measured for correlation to commuting variables was light rail transit stations only (Table 1). People who drove alone to work were found to have a moderate correlation of .313 with distance to a light rail station, meaning that the greater the distance from the transit station the greater the

correlation. This means that workers who live farther away from light rail transit stations are more likely to drive to work. People who used public transit had a moderate correlation of $-.337$ to these stations, while people who walked to work were found to have a weaker correlation of $-.147$, meaning that the shorter the distance they live to a transit station the more likely they were to use those modes. All three of these variables were significant at a $.01$ level or less, while carpoolers, other means, and work at home were not found to be significant.

Table 1: Distance Correlations

		Distance to LRT	Distance to Bus Transfer	Distance to TRE	Distance to Bike Transfer	All Transfer Points
Drive Alone Percentage	Pearson	.313**	.237**	.297**	.270**	.330**
	Correlation					
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	527	527	527	527	527
Carpool Percentage	Pearson	-.051	-.096*	-.106*	-.001	-.089*
	Correlation					
	Sig. (2-tailed)	.238	.027	.015	.988	.040
	N	527	527	527	527	527
Public Transit Percentage	Pearson	-.337**	-.254**	-.222**	-.316**	-.323**
	Correlation					
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	527	527	527	527	527
Walk Percentage	Pearson	-.147**	-.123**	-.194**	-.178**	-.187**
	Correlation					
	Sig. (2-tailed)	.001	.005	.000	.000	.000
	N	527	527	527	527	527
Other Means Percentage	Pearson	-.056	-.066	-.126**	-.056	-.049
	Correlation					
	Sig. (2-tailed)	.200	.130	.004	.202	.262
	N	527	527	527	527	527

Work At	Pearson	-.159**	.035	-.059	-.151**	-.111*
Home	Correlation					
Percentage	Sig. (2-tailed)	.000	.421	.177	.001	.011
	N	527	527	527	527	527

****.** Correlation is significant at the 0.01 level (2-tailed).

*****. Correlation is significant at the 0.05 level (2-tailed).

The second type of transfer point measured was bus transfer centers only. People who drove alone to work were found to have a correlation of .237 with distance to a bus transfer center, people who used public transit were found to have a -.254 correlation, and people who walked were found to have a -.123 correlation. The correlations measured are similar to those in light rail transit stations in that drivers are more likely to live farther away from these points while alternative modes are more likely to live closer. These correlations are significant at a .01 level or less but are weaker in nature. These results are quite similar to the alones observed for light rail stations. Additionally, people who carpoled to work had a weak -.096 correlation to proximity to bus transfer stations, which was significant at a level of .027.

The third type of transfer point measured were TRE commuter rail stations only. Correlations with a significance level of .01 or less were: drive alone at .297, public transit at -.222, walk at -.194, and using other means at -.126. Carpooling was significant at a .015 level with a -.106 correlation rate. All of these correlations are weak but suggest that commuters who drive alone will live farther away from this set of heavy rail stations while alternative modes will live closer to them.

The fourth type of transfer point measured were bike paths points which intersected with streets. Correlations at a significance level of .01 or less were: drive alone at .270, public transit at -.316, walk at -.178, and work at home at -.151. Carpooling and other means were found not to be correlated at significant levels. The commuters who use public transit have a moderate correlation with proximity to bike paths, meaning they are more likely to use public transit if they are closer to those facilities. The other correlations are weaker but still suggest that drivers will tend to live farther away from these points while users of alternative modes will live closer to them.

Lastly, when all transfer points were considered together the results were similar. People driving alone to work was measured at a .330 correlation, carpooling to work at a -.089 correlation, public transit at a -.323 correlation, walking at a -.187 correlation, and working at home at a -.111 correlation. Drive alone, public transit, and walk were significant at a .01 level or less, while the other two variables were significant at .04 and .011 levels, respectively. Driving alone and using public transit to get to work have overall moderate correlations to these transfer points, meaning drive alone commuters tend to be farther away from them while public transit commuters tend to be closer to them. Carpooling to work, walking to work, and working at home have weak correlations with these points, meaning these groups of workings are also more likely to use these modes if they live closer to the transfer points.

With these numbers it is important to remember the difference between correlation and causality. A correlation, when deemed to be statistically significant, simply means that there is some sort of pattern in the relationship of the two variables, meaning that they are not randomly occurring. However, it does not mean that one

variable is necessarily influencing the other or causing it to occur. While an association may be taking place, causality cannot be determined from only looking correlation statistics. Other environmental, geographic, and historic factors must be taken into account. In the case of these results, a mode share being statistically significant with a group of transfer points does not necessarily mean that the location of the points is causing a higher or lower mode share in certain census tracts. It does mean that the results can be compared to their actual geographic locations, analyzed according to the strength of their relationship, and then determined whether causality could possibly be occurring. This kind of analysis is what was used for this case study.

ANALYSIS

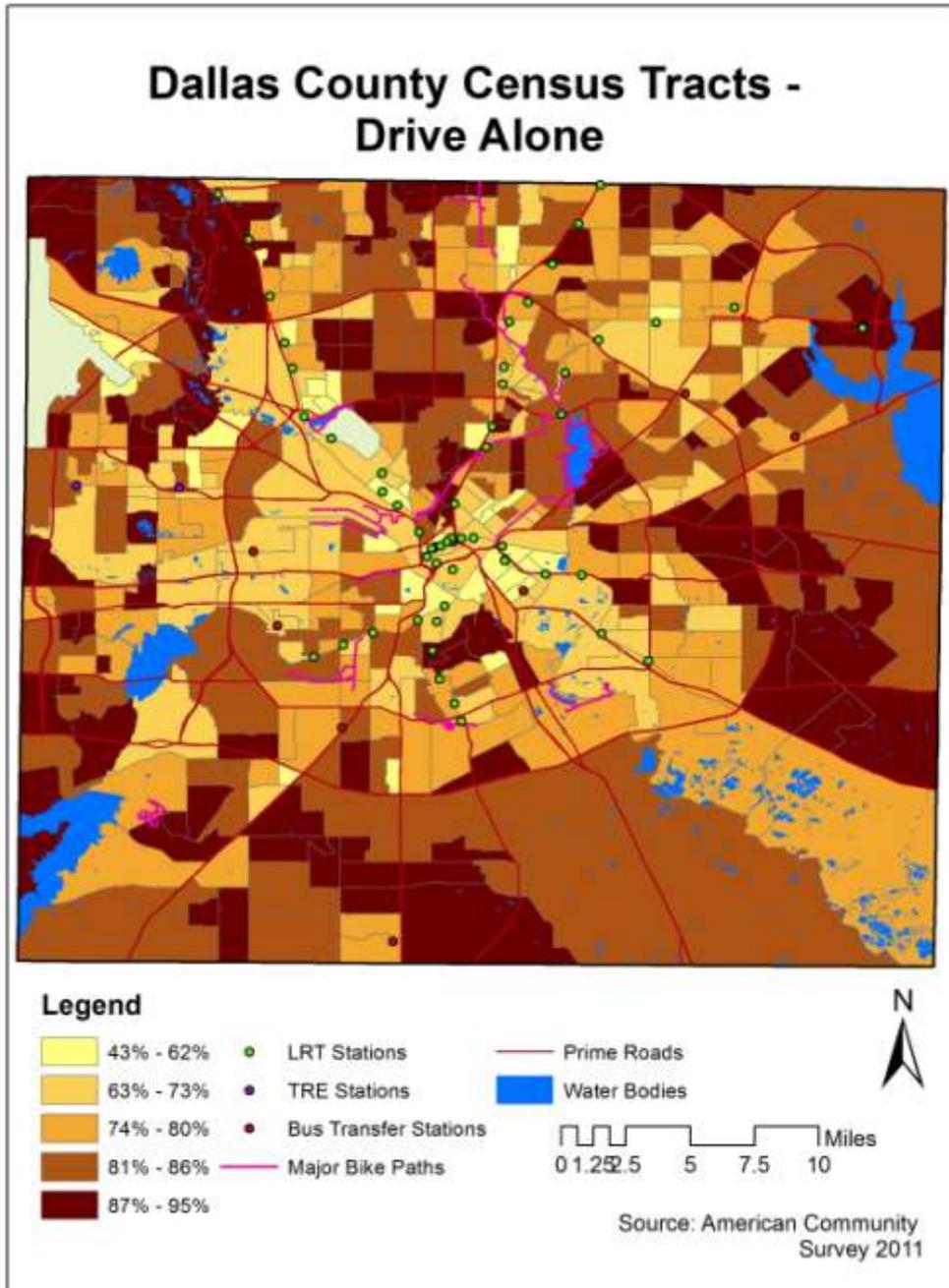
The results from the correlations run show that there is a pattern between the location of census tracts and their proximity to alternative transportation facilities as it pertains to commute mode choice. A variable of .01 significance means that 98% of the time the distance from these facilities is a determinant in how high or low the mode share for a specific characteristic will be. For determining what these correlation numbers mean, a higher the r value in conjunction with a high significance level means a greater mode share is present when there is a greater distance from alternative facilities. Conversely, the higher the negative r value, the lower that mode share is when distance to those same facilities is greater. This means that for alternative modes of commuting we would expect negative numbers in the analysis, which holds true in each scenario. We can compare these correlations to the percent of mode share in each census tract as they are mapped in ArcGIS.

Drive Alone

Driving alone is the dominant mode for commuting in all areas of Dallas County. The highest ratio of commuters driving alone to work is 95 percent, while the lowest census tract has a share of 43 percent. This is to be expected given the highway design and sprawling nature of the communities with it. Figure 10 shows that while there are census tracts with high drive alone percentages in all areas of the county, many of them are positioned towards the outer edges of the county rather than around downtown. Likewise there are more tracts with lower drive alone percentages in the central areas of the county. The correlations for driving alone compared to different transit points were measured at .313, .237, .297, and .270, and when aggregated together it remained at a similar value of .330. All of these correlations were at a .01 significance level, meaning a consistently moderate relationship between distance to transit centers and use of automobiles.

While the mode share for drive alone will be high no matter which area you are analyzing in Dallas County, it is expected to be higher in census tracts that are further away from any of the alternative transportation points. Part of the reasoning for this is that most of the transfer points, particularly light rail stations, are focused in the area immediately in and around the CBD, meaning that commuters who live close to downtown are likely to be in greater proximity to transit stations. However, there are examples on Figure 9 of tracts further away from Downtown Dallas with alternative facilities within them that have lower drive alone percentages as well. This does not mean that there is a direct link between the two, because not everyone in the county works in the CBD, but because the

correlation numbers in the Pearson's test are moderate and significant, there is certainly a relationship between distance to facilities and driving alone to work.



Source: American Community Survey

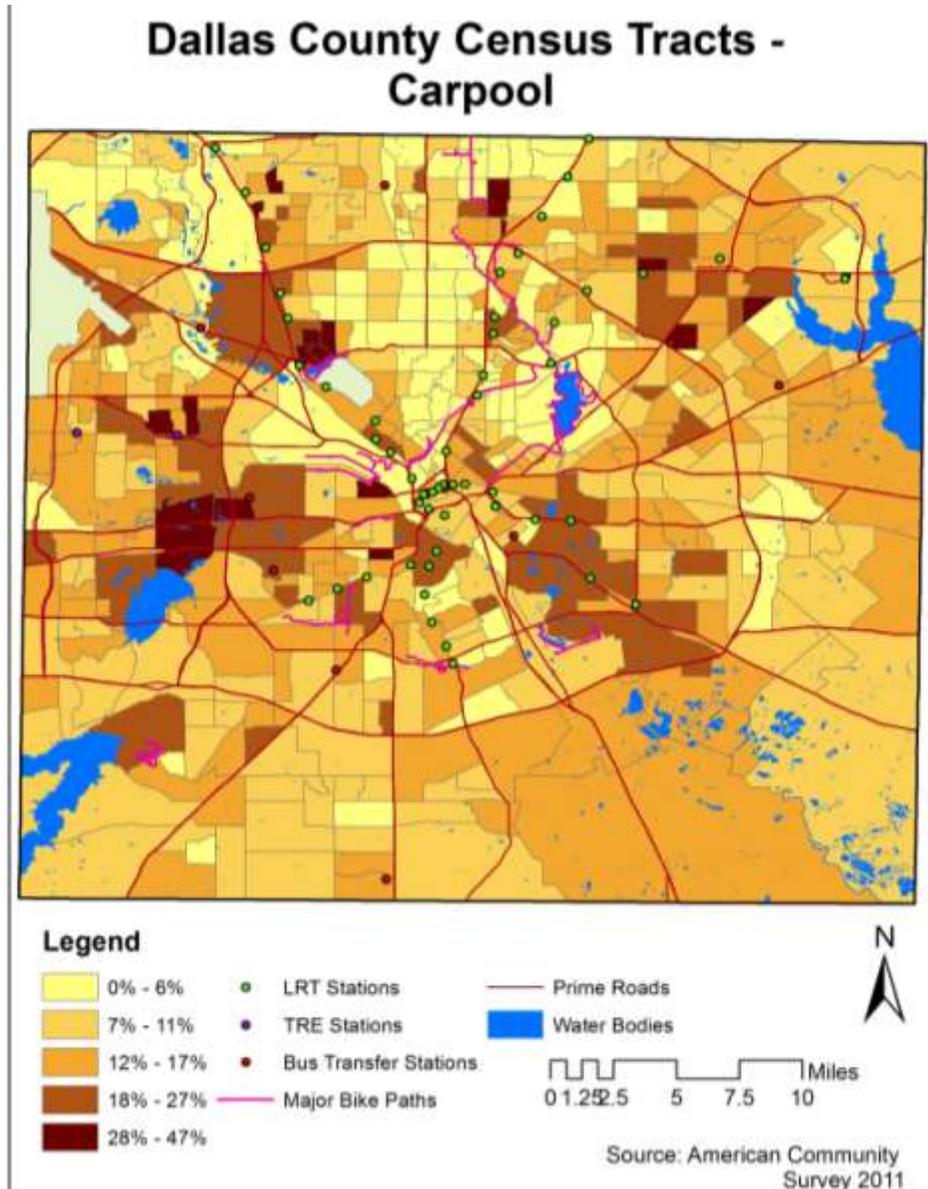
Figure 9: Drive Alone Percentage

Carpool

Automobile trips that were taken through carpools showed much less of a relationship with alternative transportation points than driving alone commutes. The only significant correlations that carpool trips had with transportation points were a $-.096$ correlation with bus transfer centers and a $-.106$ correlation with TRE heavy rail stations, with an overall correlation of $-.086$ with all transfer points. All three of these correlations are between levels of 0 and $-.3$, meaning their relationship with these transfer points was not as high as driving alone commuting percentages. However, these trips do have a negative correlation with bus and rail stations rail than a positive one, meaning that the closer the tract is to one of those points the more likely the share of carpooling is higher. It is hard to say whether this is by coincidence or if the locations of transit stations are actual affecting carpool trips.

Many transit stations in suburban areas, bus and rail, feature large surface lots or garages to allow users to park-and-ride in order to increase the amount of potential transit users. It could be that these very same parking lots, which in Dallas do not require the purchase of a fare to enter, are being used as meet up points for carpools. Looking at Figure 10, the tracts with the highest percentage of carpool commutes are usually located outside of the CBD and at places in close proximity to transit stations. However, because of the nature of automobile travel and the fact that correlation levels are relatively weaker compared to drive alone trips, it is more likely that carpool trips have a spurious relationship with transit points, meaning a third variable is causing any linkages between the two. In this case the third variable could be the highway system that both are in close proximity to because of the nature of the variables

geographies. Bus transfer centers are usually located very close to a major highway, the TRE rail line runs between Highway 183/I-35 and Irving Boulevard, and highway access naturally benefits users of automobiles. Where high carpool percentages do seem to cluster is around highways at a distance that is not overly far away from the CBD, which could be interesting from a policy standpoint.



Source: American Community Survey

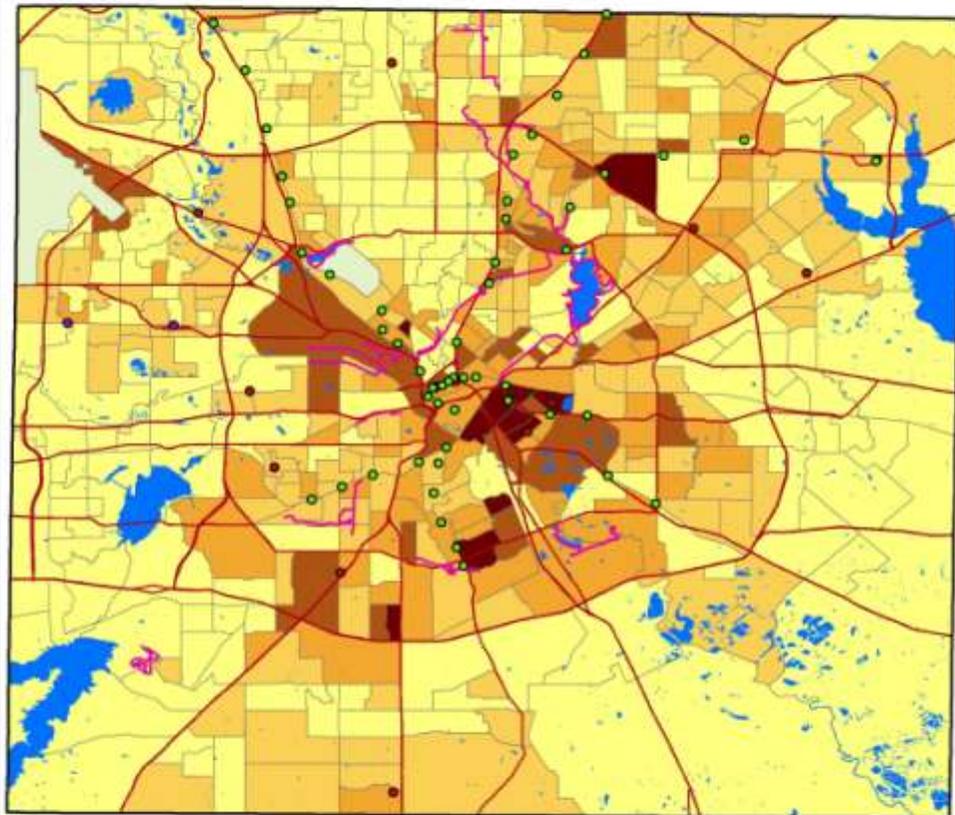
Figure 10: Carpool Percentage

Public Transit

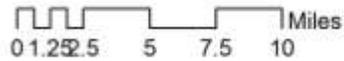
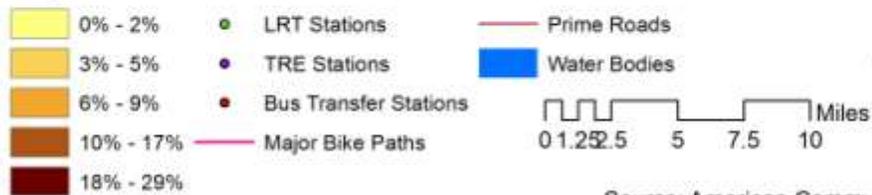
The American Community Survey commuting data that is most applicable to this case study is the share of commuters who take public transportation to work. When comparing the mode share of transit commuters to the locations of transit stations, it should be expected that the percentages will be higher for tracts in closer proximity to those points. The results showed that percentage of public transportation commuters had a $-.337$ correlation with light rail stations, a $-.254$ correlation with bus transfer stations, a $-.222$ correlation with TRE stations, and a $-.316$ correlation with bike paths, giving it a total correlation of $-.323$ with all of them combined. All of these correlation scores were at a consistently moderate level, meaning it is more likely that a census tract nearby an alternative transportation facility will have a proportionally greater amount of transit users.

Looking at Figure 11, we can see that there are indeed higher levels of transit users where stations are located. Many of the darker shaded census tracts are in areas closer to the CBD, which could mean that transit use is only convenient at a comfortable distance from the place of work. There are examples of census tracts further outward in the county with higher percentages of transit use, particularly ones nearby the northern segments of the Red and Blue lines. These two light rail lines are much more established than the newer Green and Orange lines, suggesting that the presence of stations further away from the central city takes more time to draw higher levels of ridership from the areas around it. Regardless, it is highly encouraging that transit commuters are clustered in areas where they can take advantage of these facilities.

Dallas County Census Tracts - Public Transit



Legend



Source: American Community Survey 2011

Source: American Community Survey

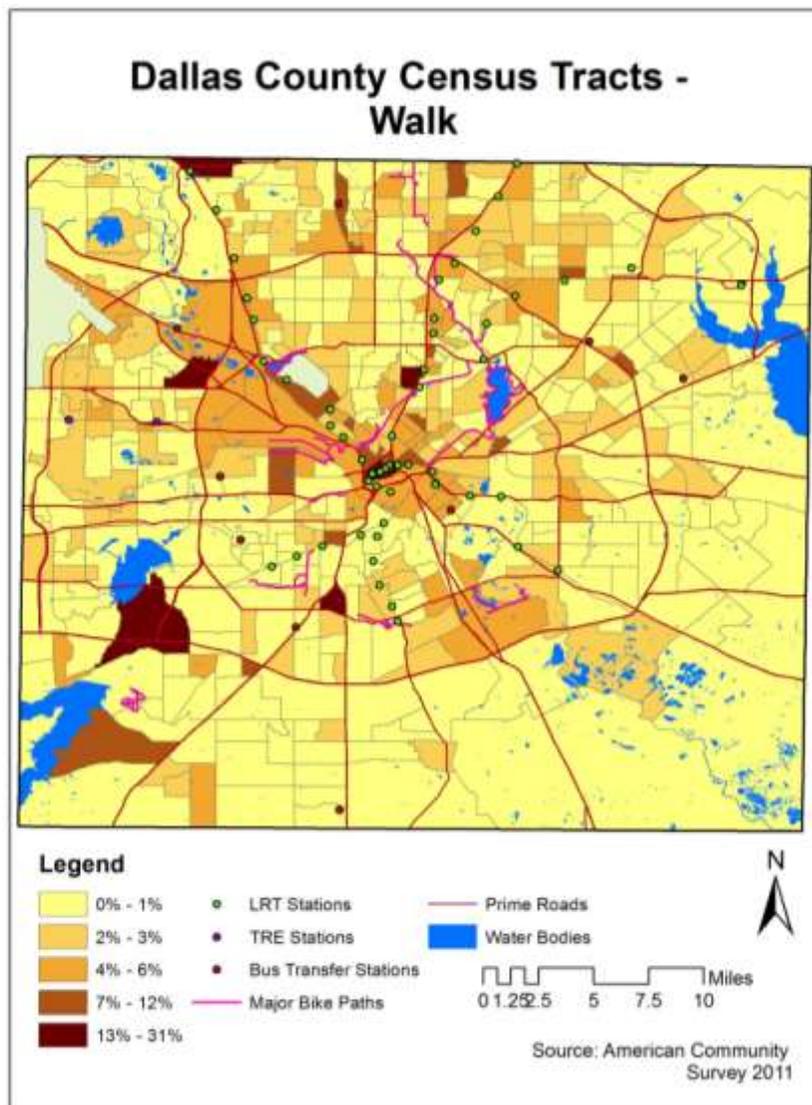
Figure 11: Public Transit Percentage

Walking

It is expected that walking trips to work will generally have one of the lowest modal shares in a given census tract, given that a person can only reasonably walk so far and the other, faster modes of travel which are usually available. Walking trips can be expected to be taken by people who can afford to live in close proximity to their workplace or by those who cannot afford to travel to work by any other means. The correlations for walking commute percentages are -.147 for light rail stations, -.194 for TRE stations, and -.178 for bike paths. The total correction to transfer points is -.187, and all four of these correlations are at a .01 significance level or less. It is hard to say whether this is a spurious relationship or if there is a real connection between the two. It could be that a commuter is able to walk to work instead of driving there because they are both close-by to their workplace and near public transportation in case they need to travel further, possibly due to residential self-selection to be near these places.

A major factor to consider is the amount of light rail stations that are concentrated in and around Downtown Dallas. Union Station, West End, Pearl, Akard St. Paul, and Pearl/Arts District stations, as well as bus transfer centers, all fall within the concentrated CBD, while many other stations are directly outside of it. Also, because the TRE shares three stations in Dallas County with light rail trains, the correlation with the commuter line could be because of double counting. Figure 12 for walking commute percentages shows that many of the highest levels of these trips are also located in this area, meaning that people who live there would be able to walk to work without any consideration for transit stations. However, there are

examples of tracts further outside of downtown with higher percentages of walking trips to work, some of which are in close proximity to transfer points. While a final conclusion cannot be made about this particular mode of commuting, it certainly would not hurt the accessibility level of someone walking to work to also be within walking distance of public transportation or bicycle facilities if they need them.



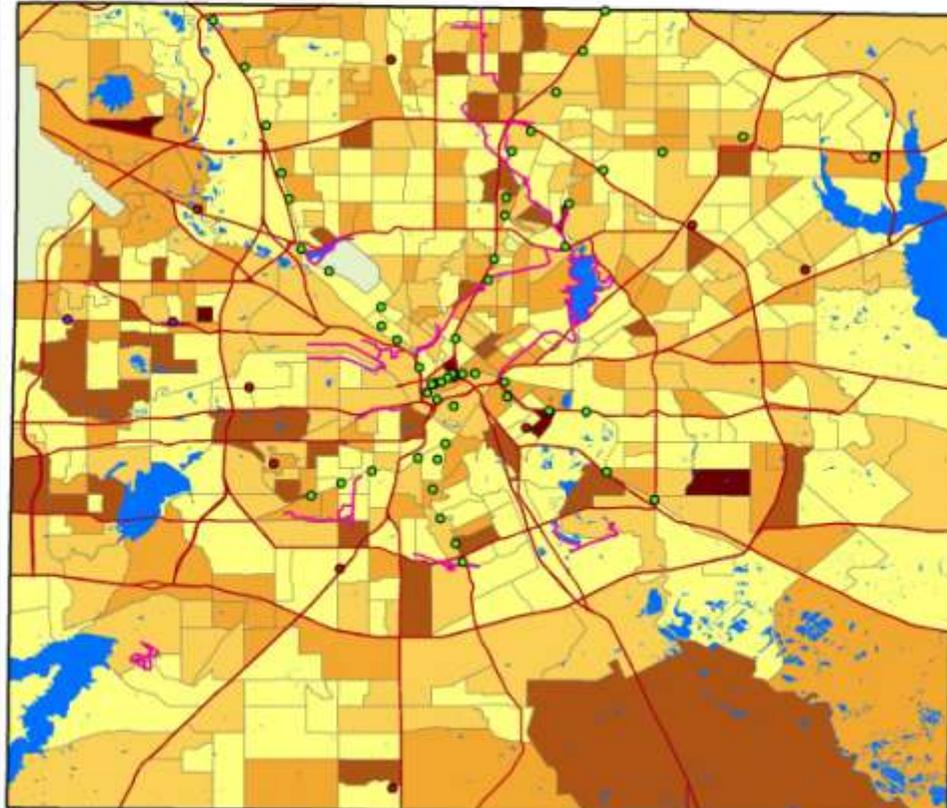
Source: American Community Survey

Figure 12: Walk Percentage

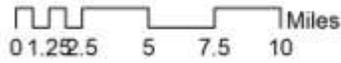
Other Means

Travel to work by other means is a somewhat ambiguous statistic in the American Community Survey commuting data. While it reveals what kind of travel that mode share is not because it is in a different category, it is difficult to assume how the commuter is actually getting to work. The only significant relationship this variable had with transfer points was a $-.126$ correlation to proximity to TRE stations at a level of $.004$. Overall the other means to work data had a correlation with all transfer points of $-.069$ but at a significance level of $.116$, meaning the data is randomly dispersed in regarding most transfer points in this analysis. If the Other Means group of data is meant to include bicyclists, it is strange that there was no correlation found between higher percentages and bike transfer points. It is important to note that the Trinity Railway Express only runs in the western half of Dallas County, its track cutting through Irving until it reaches its terminus at Union Station. This means that the commuter data on a whole is not very well represented with only this singular analysis. According to Figure 13, there are higher percentage level tracts in the areas surrounding the West Irving and Downtown Irving stations. However, the higher percentage tracts appear to be very scattered across the county, and because one cannot be sure how these commuters are traveling, it is hard to determine any causality with this data.

Dallas County Census Tracts - Other Means



Legend



Source: American Community Survey 2011

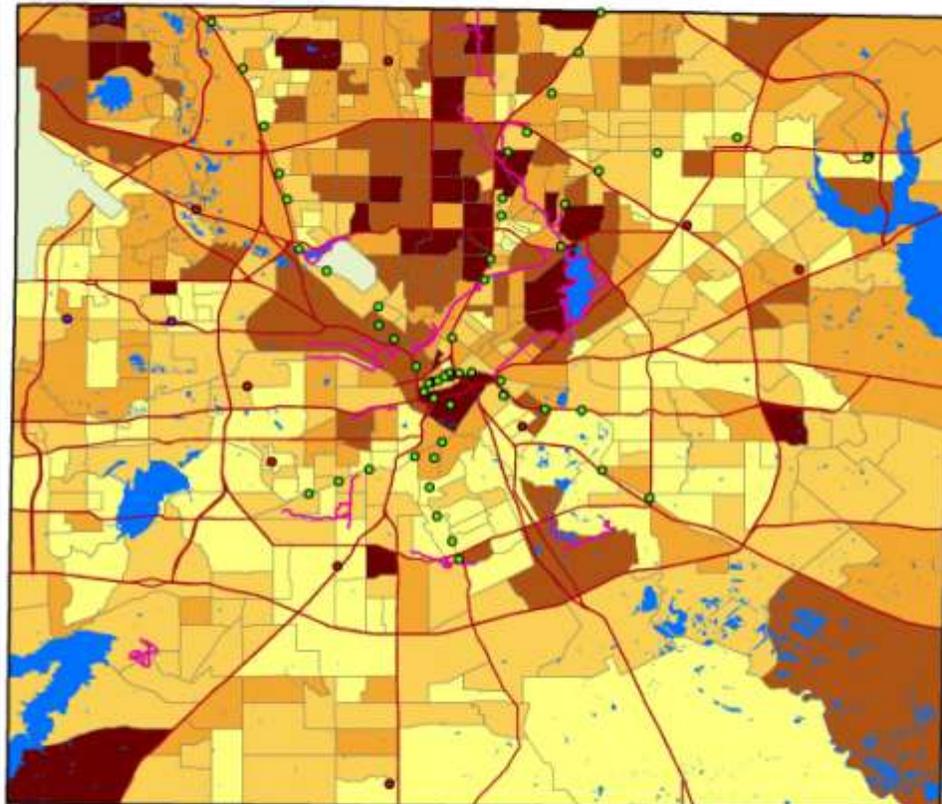
Source: American Community Survey

Figure 13: Other Means Percentage

Work at Home

The final measure of correlation with commuting data is the work at home group. Like the example trips of telecommuters from the Try Parking It data, these are workers in the census tracts that are not actually traveling to a work site most of the time. The correlations at a significant level of .01 or better were -.159 in relation with distance to light rail stations and -.151 with bike transfer points. Overall work at home percentages had a -.111 correlation with all transfer points at a significance level of .011, just slightly above the 98% confidence level. As with the walking commuter data, what is causing this correlation may not actually be the proximity to light rail and bicycle paths, because if these people are working at home they do not have a direct use for alternative transportation in these situations. Figure 14 for this data shows that the majority of these census tracts are in the northern half of Dallas County. This is where many of DART's light rail stations and most of the city's bicycle infrastructure exists as well as where the more affluent populations in the area are clustered. In fact, the causality of this relationship may be the other way around, particularly with the case of the bike paths. The reason the Katy Trail and White Rock Lake Loop exist are because they have received funding to be constructed and maintained due to the area they are in and the demographic they serve. If there were more significant bicycle infrastructure in the southern half of the county, this mysterious correlation could very well disappear.

Dallas County Census Tracts - Work At Home

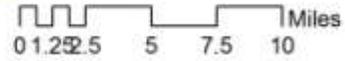


Legend

- 0% - 1%
- 2% - 3%
- 4% - 6%
- 7% - 9%
- 10% - 20%

- LRT Stations
- TRE Stations
- Bus Transfer Stations
- Major Bike Paths

- Prime Roads
- Water Bodies



Source: American Community
Survey 2011

Source: American Community Survey

Figure14: Work at Home Percentage

Overall the analysis shows that proximity to alternative transportation facilities does matter when determining shares of mode choice. Higher levels of automobile commuting are likely to come from areas without quality public transportation. Transit and other types of commuters are more likely to come from areas closer to these facilities due to either self-selection or availability. This does not mean that in every place there is a bike path or light rail station there will be a great number of commuters who utilize them. There are still factors such as personal comfort, income, and family size which also help to determine what choice of mode a commuter will make. By giving more people the option to travel by means other than a car and increasing their accessibility to the overall system, the possibility of them using an alternative mode of travel greatly increases.

DISCUSSION AND POLICY RECOMMENDATIONS

From research gathered for this paper from journal articles as well as city and transit agency websites, the evidence shows that building up facilities and amenities for alternative modes of transportation attracts people to use those modes when they would not have done so before. This can be thought of as a similar version of the induced demand created when more highway lanes are built for cars to use. However, land use is also important in determining where places in a city will be located, and the way most land uses have been arranged accommodates only personal automobiles. Automobiles are better for spread out land uses because density is not a requirement for them to achieve their means of providing mobility. Therefore cities with less separated land uses also tend to see higher uses of other transportation modes because the option is realistically available for people to get to work and other places

without needing to use a car. Cities should take steps in both directions if they desire to increase the amount alternative and multimodal commuting to their job centers.

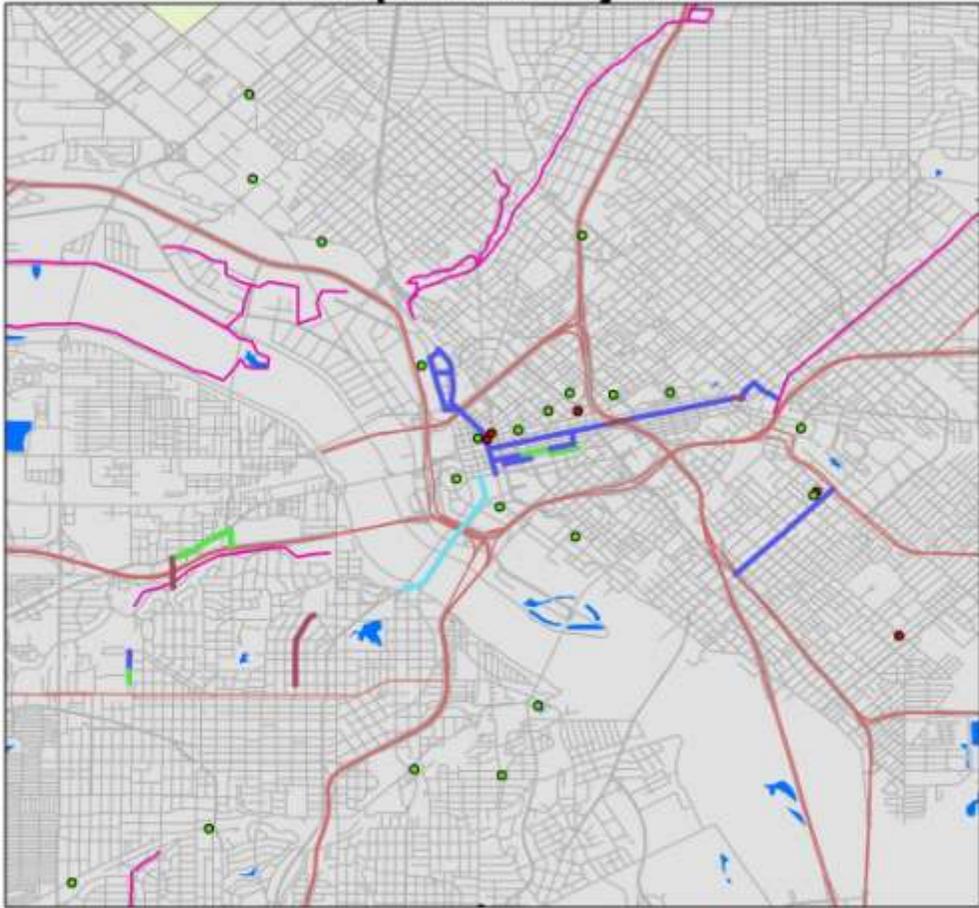
For an area as focused on the automobile as it is, Dallas is doing a lot of things right to encourage residents and commuters to use other modes of transportation besides the automobile. DART has brought quality transportation service to the most populated areas and key attractors within its member cities. They have expanded light rail service to previously unreached parts of South Dallas, Irving, and Carrollton and connected those areas to the downtown core. Further service will extend all the way to the D/FW International Airport and connect the major attractor with the Central Business District as well as the major employment areas along Highway 635. Along with light rail DART operates an extensive bus system and attempts to connect the two modes at shared stations whenever possible. The more connections the county has between its transit stations and its places of interest the more the system will be utilized by riders.

Meanwhile, Dallas has focused efforts on bringing both business and residential growth in Downtown. One of the major highway projects recently completed in the area was the Woodall Rogers Freeway Tunnel. The heavily used freeway connects Interstate 35 and Highway 75 by travelling right alongside the CBD. For years it constrained the growth of the dense urban area by cutting it land off on its western side and making it only accessible by a few bridges. Dallas saw the opportunity to grow its downtown with the area to the west by increasing the road and pedestrian connectivity to it with highway construction. After several years in the making this portion of freeway now runs underground, new skyscrapers and

residential lofts are being erected across from the traditional CBD zone, and in between them is Klyde Warren Park. This space attracts pedestrians throughout the day increases the kinds of land uses around it. Dallas needs to continue these kinds of projects, big and small, to figure out ways to connect the area together in other ways besides roads. Separating land uses apart from each other increases road congestion in the long run. Bringing land uses together helps defeat automobile dependence.

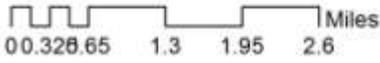
The city is working on following through with the vision and connections mapped out in the Dallas Bike Plan, but so far progress has been slow. There have only been a few areas that have seen the construction of bicycle facilities due to budget constraints and political barriers. However, the good news is that this new construction has focused on separated on street bike lanes rather than shared lanes with cars. As can be seen on Figure 15, some of these lanes are even on the streets of downtown, something that would have been unheard of in years past and definite progress towards making Dallas more bike friendly. The plan calls for separated bike lanes, marked bike lanes, and shared lanes, and more off-street paths to be installed in phases. While the planning of a complete network is good, it should try to lean more heavily on creating distinct bike lanes rather than requiring bikes to travel with cars, considering that drivers in Dallas are not accustomed to sharing space. Even if this meant sacrificing the creation of some of the lesser facilities, the yields would be greater from higher quality bike lanes.

Dallas Bike Plan - Completed Projects



Legend

- Bike Lanes
- Buffered Bike Lane
- On-Street Cycle Tra
- Shared lanes
- Major Bike Paths
- LRT Stations
- Bus Transfer Stations
- TRE Stations
- Prime Roads
- Water Bodies



Source: City of Dallas 2013

Source: Dallas Bike Plan

Figure 15: New Bike Plan Facilities

Another chief concern is connecting bicycles to both land uses and other travel modes. This is done by including bicycle racks and parking at major activity centers and allowing bicycles onto public transit itself, both of which DART has addressed. At many of the light rail and bus transfer stations are Bike Lids which allow storage for one or two bicycles underneath them. They are similar to bike lockers in that they protect the bicycle from adverse weather conditions and secure it from being easily stolen, but because of their construction they do not allow people to use them for things other than bicycles. Most stations have only 2 Bike Lids currently, so as the number of transit-cyclists increases more of them will need to be installed. DART also has bike racks on the front of its buses and allows bikes to be taken onto rail cars when they are not heavily crowded (DART). As is the case with Bike Lids these accommodations can only serve a limited number of users, but they are up to standard with most major metropolitan transit agencies. As Dallas gains more bike infrastructure throughout the city, more of these kinds of facilities and services will need to be offered to increase demand to its fullest potential.

CONCLUSION

Dallas faces many challenges as it continues to grow outward and congestion increases on its highways. Although it is built for the car, strides have been taken to make other modes, chiefly light rail transit, more attractive for commuters and other users alike. The data from NCTCOG and the American Community Survey shows that not only are there a sizable amount of workers who commute by non-automobile modes, but that where they live and their proximity to transportation nodes plays some role in the choice they make

about how they will travel to work. It is not a rule that people who live near connections to transfer points will be more likely to use them, but the results and analysis shows that a correlation indeed exists, meaning that if these connections are built in the right locations and integrated with each other, the opportunity presented by the choice is likely to lead in usage. Even in a Southern, automobile-patterned city such as Dallas, public transportation, bicycle lanes, and land-use mixtures can lead to more people changing their daily routine of driving to work.

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Todd Hansen

Measuring Pedestrian Accessibility on Both Sides of the Border: A Case Study of Austin, Texas and Chihuahua, Mexico

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Abstract – This comparative study examines pedestrian accessibility for elementary schools in two international cities of similar size: Austin, Texas (USA) and Chihuahua (Mexico). Using geographic information systems (GIS), a connectivity analysis is performed for ¼ and ½ mile radius of elementary schools, which include measures of intersection and street density, connectivity node ratio, link-to-node ratio, and average block length. The results show that pedestrian accessibility is higher for the Mexican city overall, although accessibility for each individual school varied considerably. The results also show that the effective walking area is also lower overall for the US city. This research suggests that differences in urban form from one country to another have resulted in differences in pedestrian accessibility.

INTRODUCTION

Postwar changes in land use patterns have given way to an exponentially motorized travel dependency and an accelerated abandonment of the original travel mode: walking. In turn, the predominance of the automobile has influenced land use schemes by allowing further urban sprawl and reducing opportunities for use of non-motorized travel.

Active transportation trips may have been significantly reduced but they still hold “the highest rate of injury and fatality rates on a per-mile basis” (McMillan, 2005). It could possibly be due to a lack of appropriate infrastructure or a poor integration between the motorized and non-motorized transportation network.

Urban design movements, such as New Urbanism and Smart Growth, considered this to be the main reason behind a considerable drop in physical activity nationwide, which in turn is believed to be directly linked to increasing obesity rates. Despite the growing popular awareness of the benefits of physical activity, a predominant section of U.S. population still does not meet their recommended daily prescriptions for it (Estabrooks & Lee, 2003). This increasing lack of activity and non-spent calories accounts for growing obesity rates in adults as well as children (McMillan, 2005).

Over the last 10 years “the proportion of adults who are obese rose by 47.8%; [...] for children aged 6 – 11 obesity rates rose 54.5 % and adolescents 12-19 rose 63.3%”, according to the Healthy People 2020 report (pag 19-3). The formative years of a person set the pace for the behavior of their organism in subsequent years (McMillan,2005). Children battling with obesity are more prone to developing diabetes or heart problems as adults if the overweight

problem is not addressed. (Colorado State University Extension, 2012).

Walking remains the most natural and common form of adult activity (Zhu & Lee, 2009)(Saelens & Sallis, 2003) (Krizek & Birnbaum, 2004). Levels of walking used to be just as high for children but they have decreased considerable over the last 60 years. Considering that children are unable to independently use some of the most popular transportation modes among adults this has many consequences, including a decrease in active commute to school of roughly 28% over the last 40 years (McDonald, 2007).

The consequences of lack of activity and poor nutrition, in terms of health have been widely documented, and it has been theorized that we are facing the first generation of kids that will not outlive their parents. A push for an increase in walking is justified because it is our natural and elemental way of personal travel, not to mention "a sustainable, healthy way of transportation that can improve environmental quality"(Zhu & Lee, 2009).

Previous studies, including that of Schlossberg et al. (2007), have found that urban form matters when it comes to walking to school behavior. The existence of the relationship between urban form and walking to school behavior has been established but the degree to which it affects behavior or the nature of the relationship is still being looked into.

Background

The public realm not only offers the opportunity for interaction but also allows the proper space for activity. Research into environmental determinants of health found that "streets are the

most popular and used facility for daily activity among adults”(Giles-Corti & Donovan, 2002). Since the users are already there, Giles-Corti & Donovan (2002) recommends creating more public environments that enhance walking not only for recreation but also as a transportation mode.

Seeing that walking is no longer perceived as a functional mode of transportation, it has been relegated to a leisure activity. According to Montemurro et al. (2011), good connectivity provided, the introduction of more destinations to the network would help transform more walking trips into task-oriented ones. Better connecting schools to the transportation network could provide the proposed destinations because active commuting is a task-oriented trip for children. However, information on children behavior on this topic is limited.

Ewing, Schoorer and Green (2004) and Handy (1996) argue that children are more likely to walk if the trips imply short distances and adequate walking environments. However, McMillan (2005) found results from previous literature that suggest environmental traits are not the only ones affecting behavior. They have a relationship with decision-making but it may not be as direct as we think.

Trends in walking indicate that trips made by elementary school children have suffered the biggest declines. Research has also found a higher proportion of minority children among those currently engaging in walking (McDonald, 2007; Zhu & Lee, 2009; Davidson & Werder, 2008).

Additionally there is a geographical overlap between places of residence for minorities’ children and children living in low-income households. Given the limited transportation options for these social

strata, minority children have higher walking rates not by choice but due to lack of alternative transportation modes. As a result, they are probably not walking in welcoming environments and are “more susceptible” to harm and pollution (Zhu & Lee, 2009; McMillan, 2005). Estabrooks and Lee (2003), argue that residents of low-income neighborhoods “may have very limited control over their own physical activity in the face of inaccessible environments” (pag. 103) based on a phenomenon called deprivation amplification. It implies that low-income neighborhoods lack the infrastructure and public resources to make up for “individual deprivation” and as a result are more susceptible to the negative effects of the lack of activity. Increasing the opportunities and safety for natural physical activity, such as walking to school, could help curb those effects.

In conformity to all of the above, Healthy People 2020 has among its objectives for environmental health to “increase the number of walking trips to school by children 5 to 15 years olds for a distance no greater than 1 mile” (pag. PA-13)

Implementing such measures could also achieve improvements in personal health based on the fact that children who walk to school or have a good level of physical activity have better cardiovascular health than those who do not (Davidson & Werder, 2008).

Purpose

The decline in children’s physical activity rates, exemplified by the decline in active commuting to school due to shifts on socioeconomic factors and a lack of appropriate spaces, demands attention from all angles. The purpose of this study is the identification of “weak

spots” for active commuting based on places where the infrastructure to do so, is lacking.

Addressing diminished accessibility, measured in terms of street connectivity, could help increase children walking to school behavior if interventions are sited in locations where populations are more prone to walking. Consequently, targeted interventions have a higher possibility of success. Unfortunately locations for interventions, like sidewalk closures and provision of new infrastructure, are chosen through a less than scientific process. The present paper looks into a possible way of finding said locations based on spatial analysis.

Scope of Study

This paper looks into the objective walkability of the environment surrounding elementary schools. Montemurro et al. (2011) defined objective walkability as the measurement of built environment features that can be quantified into indices of actual possibility for walking. The most common of such indices are those of accessibility that deal with measurements of connectivity within an urban network.

Previous literature talks about the use of perception based methods, however those are not the focus of this analysis for a number of reasons. First, the appropriate data is unavailable and primary data collection was not feasible given limitations in time and resources. Besides, studying examples in two countries using perceived walkability is bound to introduce bias based on cultural differences between users. The definition of “walkable”, for example, can be vastly different from city to city, not to mention from one country to

another. McMillan (2005) also mentions how literature focused on perception's influence on travel or physical activity in children is still insufficient.

The focus of this paper is on environmental variables because they are tangible and changes in them imply less time, both in terms of implementation periods and results, than educational efforts. Behavioral and socio-economical variables are being widely researched by disciplines previously mentioned like physical health and urban design.

The analysis was confined to the capital cities of both the contiguous United States and Mexico's largest states, based on shared geographical and socioeconomic characteristics. The definition of both cities and their information is discussed later in the paper. Focusing on the details at a neighborhood level, the paper was focused in the analysis of low-income census tracts to identify strategic intervention points.

Limitations of the Study

Results from the following study should be evaluated considering the following limitations. All accessibility studies based on connectivity measures are based on a network database representing infrastructure on the ground. Due to unavailability of recent and reliable pedestrian networks, the present study was conducted using street networks as proxy for pedestrians ones. This limits the accuracy of the accessibility measures, given that analysis may have overlooked pedestrian paths that do not follow existing streets.

In an effort to minimize skewing of the results, highways and major arterials were removed from the network as they pose minimal to no accessibility for pedestrians, however network analysis did consider connections through them at street intersections.

Consideration of socioeconomic variables was also limited due to differences in demographic information and the definition of their categories in both countries. Low-income households, for example, do not have the same yearly income and thus cannot be considered under similar terms. Unemployed population was used as a proxy for low-income households, although, in the United States it might simply imply a single earner household. Given the previous considerations, case studies were selected based on population and school-aged children (5-12 years old) densities. Economic variables (unemployment) and geographical location were then used to narrow the selection and choose the final case studies.

While the study measured accessibility from schools' main access doors, campus configuration for U.S. schools is much more open than their Mexican counterparts, which might allow for multiple points not considered in this study. If such alternative access points are available accessibility might be higher than that showed by this study.

Finally, density calculations were made based on census tracts in spite of the fact that Mexican census tracts tend to be smaller than American ones, as a consequence the differences could have been increased to a certain degree.

STUDY AREA BACKGROUND

Motorized transportation currently reaps the benefits of an extensive and well-connected network. The same cannot be said in every case for pedestrian and bicycle transportation where connections are either few or far apart, which challenges user safety and comfort. In terms of connectivity, an ideal network is one where “there is a lot of short links, numerous intersections and minimum dead ends” (Victoria Transport Policy Institute, 2005) Such a network increases route options and reduces unnecessary travel, making it easier to use by non-motorized transportation.

The following study uses GIS spatial analysis capabilities to assess common network connectivity measures to:

- Contrast and compare the level of accessibility between two similar cities, Austin and Chihuahua, as a result of different national policies.**
- Identify facilities where changes in the sidewalk network could make a bigger impact on walking to school rates within both cities.**

City Profiles

According to McMillan (2005) there is a significant difference in walking rates around the world. Information on this subject for Latin America is scarce, but Europe proves the point well with a difference of more than 15 percent in the mode split for walking and biking compared to the less than 10 percent in the U.S. that use non-motorized travel options.

By contrasting similar cities in two different countries, the present study looked to identify possible differences in accessibility due to

urban form policy that could affect the journey to school for kids actively commuting. Cultural differences are beyond the scope of this paper.

The following Table 1: Basic City Characteristics shows basic city characteristics and metrics for each case study against each other. Both cities a close population total with little under 850,000 people, but the footprint they occupy is rather different with Austin's urban area more than double Chihuahua's area. The former conditions probably explain the differences in population density as well, with Chihuahua almost triple Austin's population density.

Austin experienced a development boom in the postwar period consistent with suburban urban forms contrary to Chihuahua who underwent the same process not until the 90's. Nevertheless, redevelopment in Austin is currently gearing towards density and vertical use while Chihuahua is still developing under suburban patterns.

Maps 3 Chihuahua Basic Map (page 32) and 10 Austin Basic Map (page 39) in the attachment section below show a basic outline of the cities' footprint and general urban form.

Finally, Austin has a total of 153 middle and elementary schools serving the urban area. Chihuahua, on the other hand, has 270 middle and elementary schools. Differences in enrollment capacity for school in each country might be partially due to the school consolidation policy adopted in the United States.

Table 1 Basic City Characteristics

	Austin	Chihuahua
Area	272 square miles	94.08 square miles
Total population	820,661	841,490
School aged population (5-14 years old)	113,812	126,615
Main development period	1970+80's-Major development 2000's- Skyscraper development	1960's- Major development 1990's- Suburban development
Population density	3,262.86 per square mile	8,944.40 per square mile
Climate	Humid subtropical climate	Semiarid climate
Total Schools within city limits	153 schools	270 schools

Sources: Austin. austintexas.gov, Census.gov, City of Austin GIS Data Sets Chihuahua. INEGI,IMPLAN.

Connectivity Measures

Previous studies used connectivity measures as “markers for pedestrian accessibility to local destinations” (Chin, Van Niel, & Corti, 2008). The present paper used the most common of these measures, the definitions for which are listed in Table 2.

The objective of all is to analyze the number of route options a user may have in a given environment and how easy it is for him/her to use said routes.

Table 2 Definitions for Measures of Connectivity

Concept	Definition
Intersection Density	Number of intersection points in the network per unit of area.
Street Density	Number of linear miles of street per square mile of land.
Connected Node Ratio	Number of intersections divided by the total number of nodes in the network.
Link – Node Ratio	Number of links divided by the total number of nodes in the area.
Average Block Length	Average length of block as measure from center of the intersection to center of the intersection as analyzed by ArcGIS.
Effective Walking Area or Pedsheds	The ratio between the number of destinations within a given distance and the total number of destinations that can be reached within the same distance by walking.

METHODOLOGY

The present paper uses ArcGIS to perform the spatial analysis necessary to calculate metrics for connectivity. Aultman-Hall, Matthew, & Baetz (1997) and Chin and Niel (2007) among others have used this approach for different purposes. In fact most of the recent research into accessibility is done through Geographic Information Systems.

A section of the procedure also required the usage of Network Analyst, an extension of ArcGIS, to transform regular shapefiles into databases necessary for the analysis.

Data Collection

The GIS departments for the municipal government of both the City of Austin and the City of Chihuahua have created GIS data for their infrastructure networks. A specific list of layers used and their respective sources can be found in Table 3. Other layers needed for the creation of a base map include Contours, Hydrology, and Railroad Tracks were all provided by each city's planning department. Information concerning socioeconomic and demographics traits was obtained from the US Census Bureau and National Center for Statistics and Demographics (INEGI) in Mexico.

Table 3 Data Summary and Sources

Layer	Source: Austin	Source: Chihuahua
Current City Limit	City of Austin GIS datasets website. ⁶	Institute of Municipal Planning. GIS Library Department. Chihuahua, Mexico.
Block Layout		
Street Network		
Sidewalk Network		
Census Tracts	US Census: Tiger Database	
Community Facilities	Texas Education Agency	

⁶ ftp://ftp.ci.austin.tx.us/GIS-Data/Regional/coa_gis.html

Procedure

The study began by locating the public elementary and middle schools within the boundaries of the central city in each case study. Then non-motorized buffers were established based on the assumption of the average distance an average person would be willing to walk. For this, five to fifteen minute walks were calculated at an average speed of walking for an able-bodied person (3 miles/hour for adults) that amounted to ¼ and ½ mile radiuses from the point of origin to the destination. Those areas became the study area.

Using the existing street network as a proxy I proceeded to create a Network Database. This type of database produces junction nodes and is comprised of the elements described in Table 4 Network Element Definitions.

Table 4 Network element definitions.

Concept	Definition
Link	A line segment between two nodes that represents either a street segment between two intersections or a road segment between an intersection and a dead-end.
Node	The endpoint of a link.
Intersection node	The endpoint of a link that connects to others links.
Dead-end node	The endpoint of a link that has no other connections. It is also interpreted as a cul-de-sac.

These nodes were then classified as normal intersections or dead-ends depending on the number of links they connect. The resulting values are used to calculate the measures of connectivity described in Table 2.

The aforementioned connectivity measures were used as the final unit of analysis and were calculated at a citywide scale producing

intersection and dead-end density per census tracts maps. Street density was calculated by adding up all street segments in the city and dividing them by their total area. Additionally, a total attribute count for intersection and dead-ends produced the data necessary for the calculation of both Connected Node Ratios and Node- Link Ratios for both cities. Average Block Length comes from the sum of all segments divided by the total number of segments in the city. If the average is small we can assume street segments are short and there will be a big possibility for enhanced connectivity. A good average for a traditional neighborhood type block is around 450 ft (Aultman-Hall, Matthew, & and Baetz, 1997).

In order to perform further analysis socioeconomic and demographic information were added to the model and related to the appropriate census tracts.

Contrasting population density, school children population density and unemployment all per census tract with school location allowed for the identification of facilities that could theoretically benefit more from changes in pedestrian infrastructure.

Finally based on the network dataset, and using the network analysis function of GIS service areas were calculated for all school facilities in an effort to identify zones not accounted for. In order to do so, point locations of all school facilities are included and binded with the network. The program calculates how far in the network you can reach given the distances discussed previously and plots the polygon around it. After cross-referencing these service areas with the density maps produced beforehand, three schools where chosen as case studies for each city. This study then proceeded to analyze their immediate environment by contrasting the difference between

Euclidean distances (walking radius) and distance along the network (service area) the study aimed to show the actual pedestrian shed for the facility and allow for the calculation of effective walking areas.

RESULTS

Results for connectivity citywide show an interesting trend. The overall results describe a higher level of connectivity for Chihuahua, Mexico. With almost 300 intersections per square mile it is no surprise the Mexican average block length is closer to the ideal 450 ft described for traditional neighborhoods. Austin's average is above a thousand feet signaling not only longer blocks but also the likelihood of less diversity in route choice. Also since the average link is longer it is implied that the average travel length increases as well.

Intersection density maps showed high intersection density in both downtown areas. Nonetheless neither of the downtowns have a high population of elementary students nor working schools in them so high connectivity in both is irrelevant for active commuting to school.

Higher densities of dead ends are concentrated towards the edges of both cities, however there are more census tracts with higher dead end densities in the Austin example. This is something to have in mind, since Mexican census tracts tend to be smaller than the American ones.

On street density, again we see the tendency of Chihuahua doubling Austin's average per census tract, implying more streets and more

travel routes. Pedestrian infrastructure for said routes is difficult to analyze based on the given pedestrian network lack of reliability.

However it is remarkable that when it comes to ratio measures the discrepancies are not as high as other measures might suggest. There is only a .1 difference in Connectivity Node Ratio and both measures show a high in the scale. The higher the measure is we can assume the percentage of cul-de-sacs is small and thus representative of higher connectivity. Measure of Link-Node ratio is still similar between the two cities but more towards the center of the measure scope. Taking into account that the highest score (2.5) would indicate a perfect grid network, we can infer both cities have achieved a good mixture of urban structures, even when Chihuahua has developed under the Spanish highly connected pattern for a longer time.

Table 5 Comparison of Citywide Connectivity Measures.

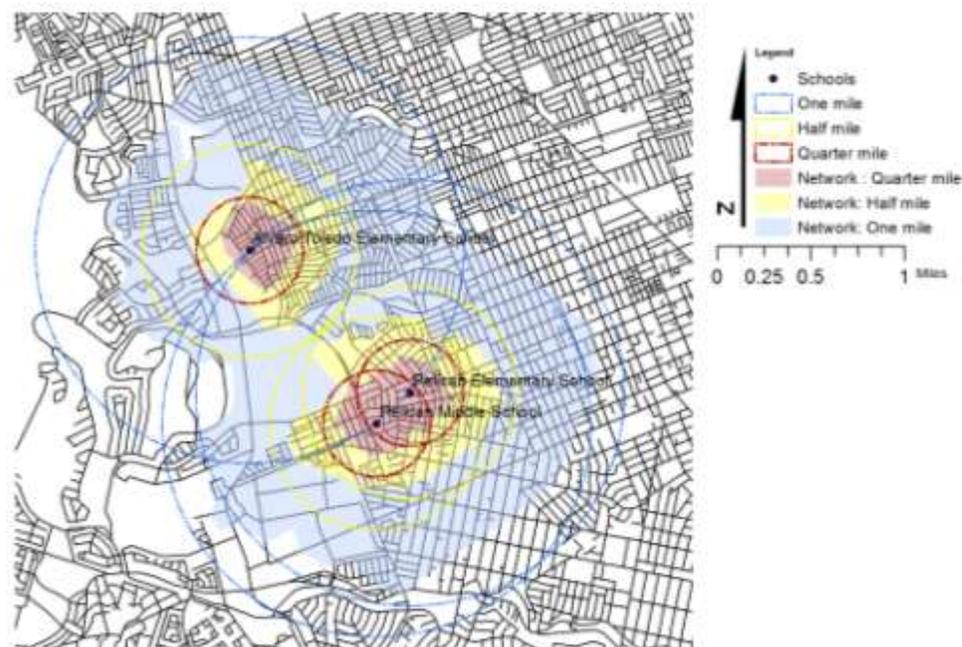
Connectivity Measure	Ranges	Austin	Chihuahua
Intersection Density	—	61.18 int/ sq.mile	285.77 int/ sq.mile
Street Density	—	12.02 miles/ sq. miles	28.78 miles/ sq. miles
Connectivity Node Ratio	0 – 1.0	0.77	0.84
Link-Node Ratio	0 -2.5	1.50	1.60
Average Block Length	250 – 2,000 ft	1,013.76 ft.	427.15 ft.

Map 1. Chihuahua School’s Accessibility Assessment and Table 6. Chihuahua School Effective Walking Areas show the results of the localized analysis on the following schools: Alvarez Toledo Elementary School, No. 78 Elementary and Middle School, Pelican Elementary and Middle School and Lion’s Club Elementary School.

The results show a minor decrease in the area accessible to pedestrians when distance on the ground is compared to distance on

the network signaling good connectivity. However it is interesting to see how the level of connectivity drops at the half a mile distance only to increase again at the mile marker; causes for this require more research in order to draw conclusions. Overall the chosen Mexican schools' effective walking areas scored in the middle of the ratio scale with averages of 0.51 at the ¼ mile marker, 0.41 at the ½ mile marker and 0.48 at the mile marker. Taking into account the scale goes from 0 to 1 with the higher scores indicating better accessibility, Alfonzo Toledo Elementary School got the lowest score at the quarter mile barrier with a 0.42, but it can hardly be qualified as a low score. All other facilities scored above .5 at the quarter mile barrier, which is still a signal of good connectivity but a rather average result. Finally, Lion's Club Elementary School is the most interesting case because it has the highest Effective Walking Area ratio of all Mexican examples.

Map 1 Chihuahua School Accessibility Assessment.



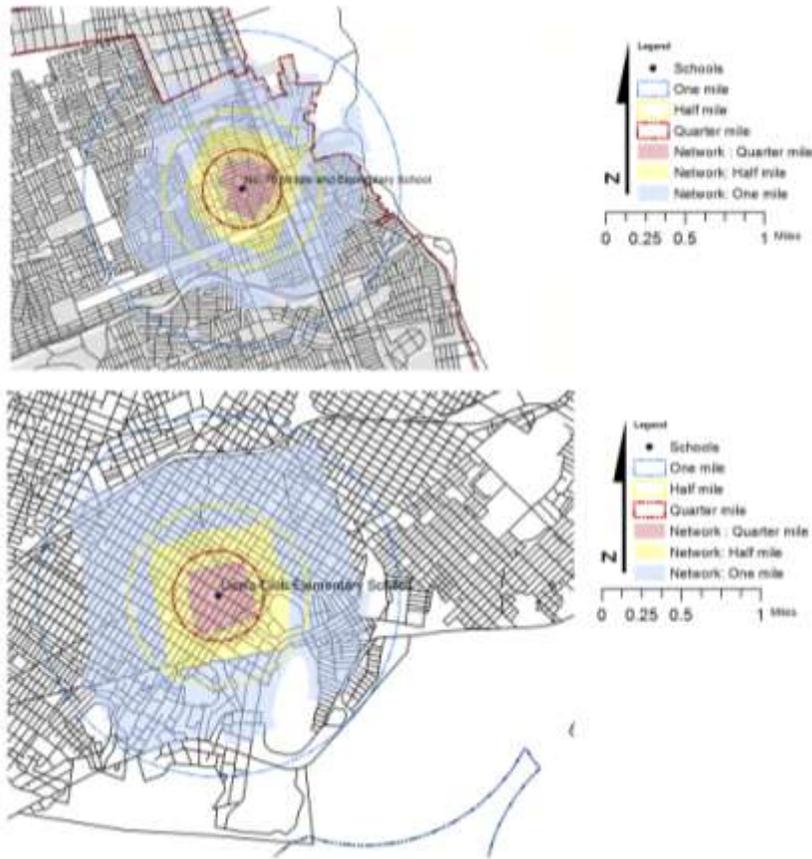


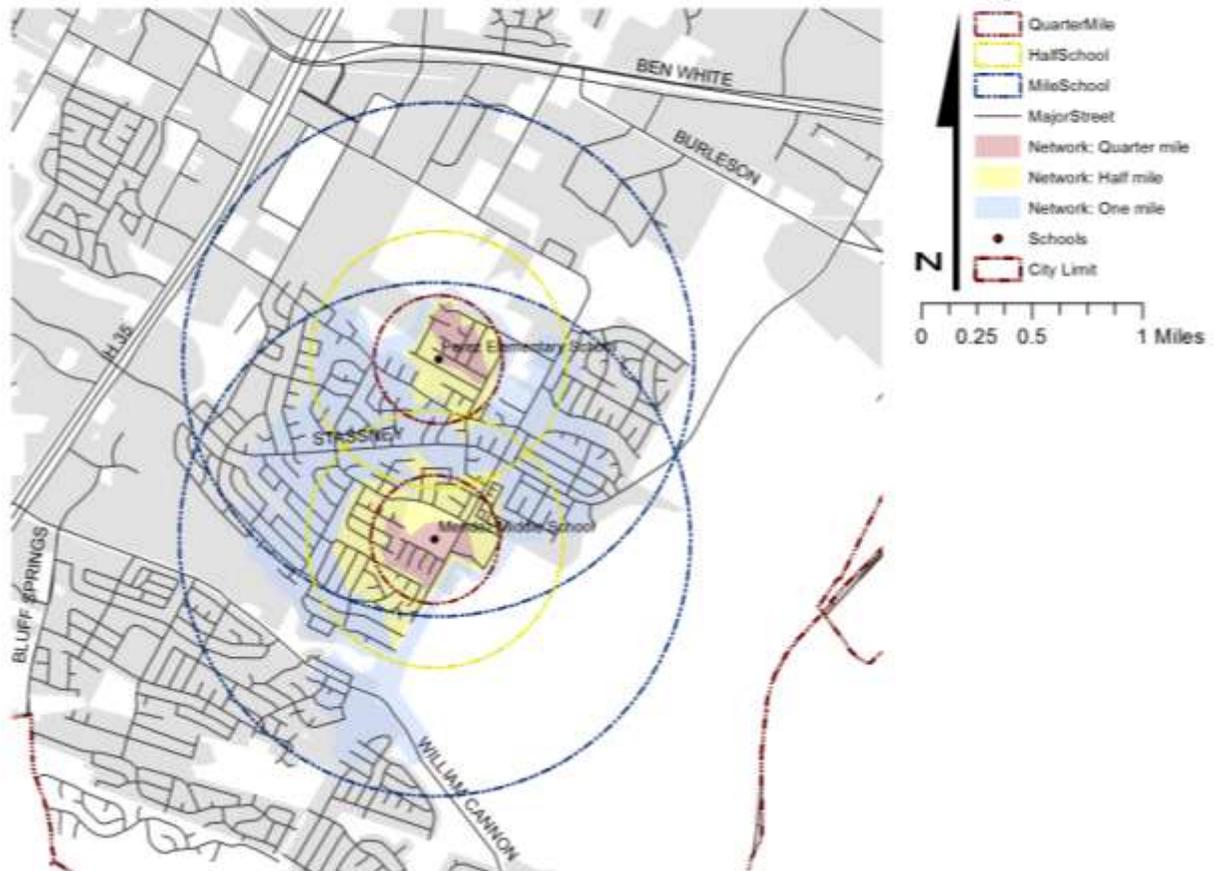
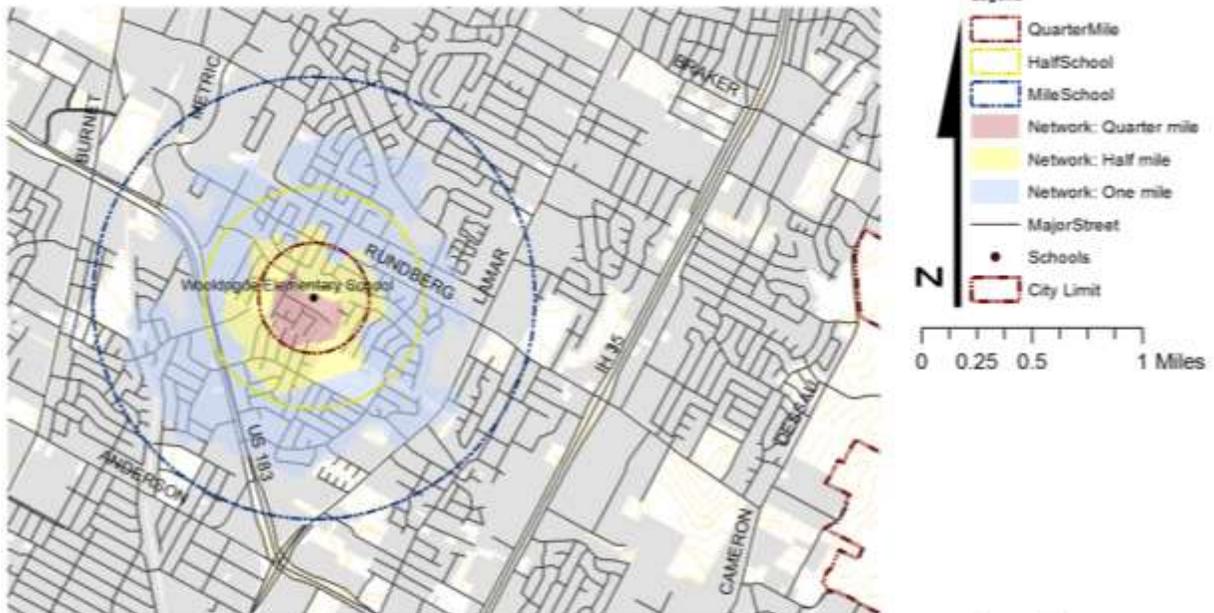
Table 6 Chihuahua School Effective Walking Areas

Schools	Chihuahua Effective Walking Area		
	Quarter Mile	Half Mile	One Mile
Alvarez Toledo Elementary School	0.429	0.326	0.479
No. 78 Middle and Elementary School	0.515	0.425	0.426
Pelican Elementary School	0.505	0.445	0.474
Pelican Middle School	0.535	0.406	0.507
Lion's Club Elementary School	0.612	0.485	0.516

Map 2 Austin School's Accessibility Assessment and Table 7 Austin School Effective Walking Area Ratios Table show the results of the localized analysis on the following schools: Mendez Middle School, Wooldrigde Elementary, North Oaks Elementary and Perez Elementary.

The results show a considerable decrease in the area accessible to pedestrians when distance on the ground is compared to distance on the network. With an average Effective Walking Area Ratio of .3 in a scale of 0 to 1, we can assume that connectivity is restricted. It is necessary to point out that the aforementioned drop in connectivity at the half-mile marker, seen in the Chihuahua case studies, is also present in this case. This again calls for extra research in order to draw conclusions. Overall the chosen American schools' Effective Walking Area ratios are two points below the median value of the ratio scale indicating lack of route options and diminished accessibility. The worst case is Perez Elementary on the southeast edge of the city. The .20 EWA ratio indicates a reduced number of surrounding roads or a single point of access which is consistent the suburban style of its environment. It is also interesting to see how accessibility for Wooldridge Elementary School increases with each distance barrier, which could be an indicator of a single point of access to the school but a good numbers of routes to get there.

Map 2 Austin School Accessibility Assessment.



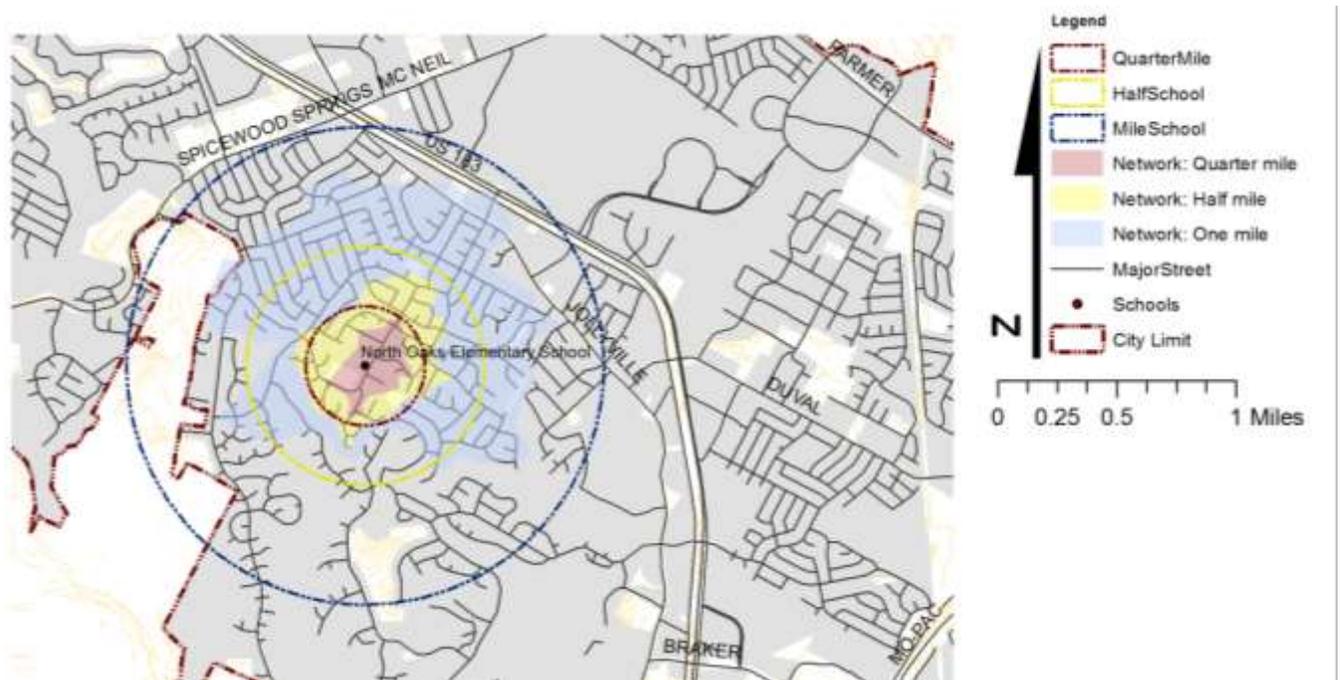


Table 7 Austin School Effective Walking Area Ratios.

Schools	Austin Effective Walking Area		
	Quarter Mile	Half Mile	One mile
Mendez Middle School	0.32	0.36	0.41
Wooldridge Elementary	0.37	0.47	0.52
North Oaks Elementary	0.39	0.36	0.39
Perez Elementary	0.20	0.16	0.25

CONCLUSIONS

Differences in urban forms from one country to another have resulted in different measures of pedestrian accessibility. However, the differences are not as proportionally nor as pronounced as it would be expected based on Austin more sprawl-like development.

Down at the micro level, schools in Austin do show a very limited Effective Walking Area and Chihuahua, while scoring higher ratios, does not exactly perform exceptionally.

Taking into account that this study was done using the street network, this can lead to an even lower score on the account of the presence of streets but not adequate sidewalks. In order to avoid this, cities should keep up-to-date and detailed records of their pedestrian facilities. Just as it is done with other transportation methods, pedestrian interventions should be made in places where they would account for more benefits to the user. Since non-motorized transportation methods are the only ones children can use independently adequate infrastructure for them is essential.

Sidewalk provision and quality improvements must go hand in hand with appropriate school location and walkable distances. Educational efforts are also necessary to help parents reconsidered their perceptions in places where the quality infrastructure is already present.

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Nair Barrios

The Winding Path: Bike Study of Texas A&M Campus

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Abstract – Bicycling, as one of the sustainable alternative transportation modes, has been promoted by many communities and organizations. Bicycling could benefit health, environment, economy, and social equity. Texas A&M University (TAMU) was rated as a Bicycle Friendly University by League of American Bicyclists in 2012. However, TAMU still has a long way to go compared to other campuses that were ranked much higher. This paper assesses the current situation of TAMU main campus' bicycling environment, and provides suggestions that might help to improve bikeway network's connectivity and safety. In order to learn more about campus, a site survey was conducted. The assessment of each bikeway is based on physical conditions, for example, existence of bike lanes and sidewalks, road pavement, and on-street parking. GIS was used to calculate and analyze the final assessment result. Design and policy recommendations are discussed based on the analysis.

INTRODUCTION

Texas A&M University was rated as Bicycle Friendly University by League of American Bicyclists in 2012 (LAB, 2013). It is one of the largest campuses in the United States. It has a diverse student population of over 50,000. The territory is flat and weather is mild. All these elements give TAMU a bike-friendly environment in terms

of nature and socio-demography. TAMU has been making effort on promoting the bike ridership and develop a more comfortable bike friendly campus. After a series of improvements have been made on campus, including adding bike lanes and bike racks and renovating the street pavement, the bike ridership has increased significantly from 2010 to 2012. This paper is trying to figure out what variables will influence bike ridership on campus and what we can do in the future to enhance the bike-friendly environment. This bike study focuses on the current situation of bike facilities on campus, including bike lanes, bike parking, signage etc., based on which, suggestions were made for future development. The purpose of this paper is to study the characteristics of travel behavior in terms of bike riding and what kind of efforts can we make to promote various travel modes in order to develop a sustainable campus

The process of this study is:

1. Figure out reasons for promoting bike ridership and factors that might have influence on bicycling based on literature review.
2. Study the current situation of Texas A&M University, in terms of demography, geography, and current supply of bike facilities.
3. Based on the literature review and the study of current situation, make suggestions for improvement of bike facilities.

STUDY BACKGROUND

Texas A&M University (TAMU) which located in College Station, Texas, is 90 miles to the northwest of Houston. TAMU is one of the largest universities in the United States and currently has over 50,000 students enrolled ("About Texas A&M University," 2013). Known as an "Aggie Community", it was the first public university in

Texas and was founded in 1871. It has large and diverse population, combined from students, faculty, and staff. About 17% of students live on campus and the rest of them live generally around campus ("Bike Share Program Survey," 2012). The main campus in College Station now has an area of about 5,500 acres ("Campus Comprehensive Plan," 2004). The campus is fairly flat, with a mild weather and not too much rain. The nature has given TAMU a good cycling environment. During recent years, there has been an effort to improve and promote different means of transportation especially biking. To accomplish this, the university has invested money into their bicycle infrastructure, such as parking and bike lanes. These initiatives promote a cycling friendly campus environment. Texas A&M University was rated as a Bicycle Friendly University by the League of American Bicyclists at 2012 (LAB, 2013).

Local Facts

The local weather of College Station is fairly temperate and with mild winters. The average annual temperature is 69 degrees, with low temperatures only lasting a couple of months. From June to September, the average high temperature is over 90 degrees. The humidity makes the winter colder and summer warmer. The average annual rainfall in College Station is 29 inches and most of the rain comes during the winter months ("Weather Facts," 2013).

The population of TAMU is young and diverse. TAMU has over 50,000 students and over 27,000 faculty and staff ("About Texas A&M University," 2013). For the fall semester of 2012, TAMU has a total enrollment of 50,227. Among them, 53.1% are male and 46.9% are female. The majority of the population is non-Hispanic White, along with 16.2% Hispanic or Latino and 8.7% international students. Students that age from 15 to 35 occupied over 85% of the total

student population (Enrollment Profile Fall 2012, 2012). If TAMU were a city, it could be ranked among the top 50 cities in Texas in terms of its population and density ("Compus Master Plan," 2004). This is not just a university, but a major urban center.

The city of College Station has a tightly knit relationship with TAMU. The city has a population of 93,857 (U.S. Census, 2010). There are 42,595 people are employed and aged over 16 years old, 39.7% of which work in educational services, and health care and social service industry. Among the people who is over 3 years old and enrolled in school, 80.9% are enrolled in college or graduate school.

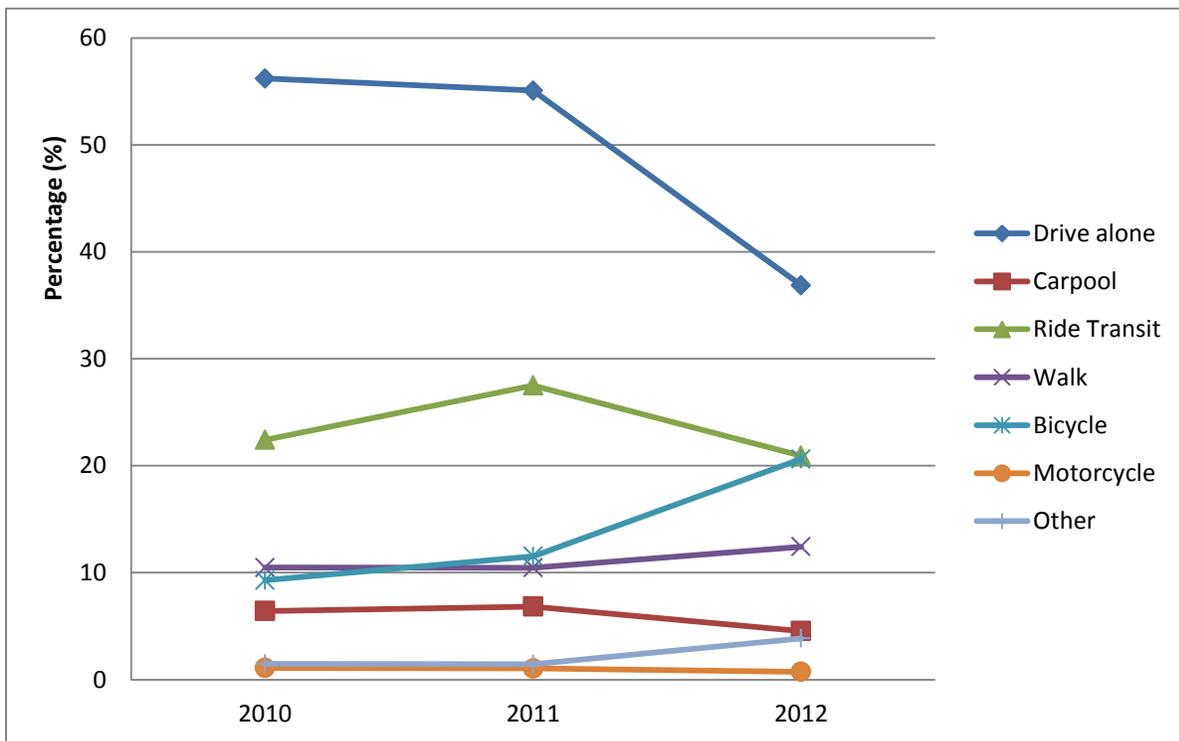
Bicycle Ridership

The Transportation Service department of TAMU estimated that there are 14,000 bikes on in 2013. In order to better understand the current transportation situation of TAMU, three campus-wide surveys about bike ridership and mode share were conducted by Transportation Service in October of 2010, September of 2011, and October of 2012. The first two surveys simply aimed to learn the travel mode share on campus, which could assist Transportation Service to better manage campus transportation system. Both surveys had exactly the same questions. The third survey was part of a research project – Bike Share Program - for the graduate course in Urban Planning and Landscape Architecture department, PLAN674, Transportation Systems Analysis. This Bike-Share Program Survey was designed to examine existing bike ridership and assess the demand for a bicycle share program on campus. Students, faculty, and staff member of TAMU were all encouraged to participate in these three surveys and the existence of these surveys

was advertised to the public through a TAMU general interest announcement list through the University emailing system. The surveys were all created by Survey Monkey, a popular survey designing tool. The participation was voluntary, confidential and anonymous. The amount of respondents differed from year to year, which makes the comparison of the exact number become meaningless. So, percentages are used to analyze the data.

All these three surveys all asked the same question, "How do you usually come to campus?" The results for each survey are indicated in Figure 1.

Figure 1 Mode Share to TAMU Campus

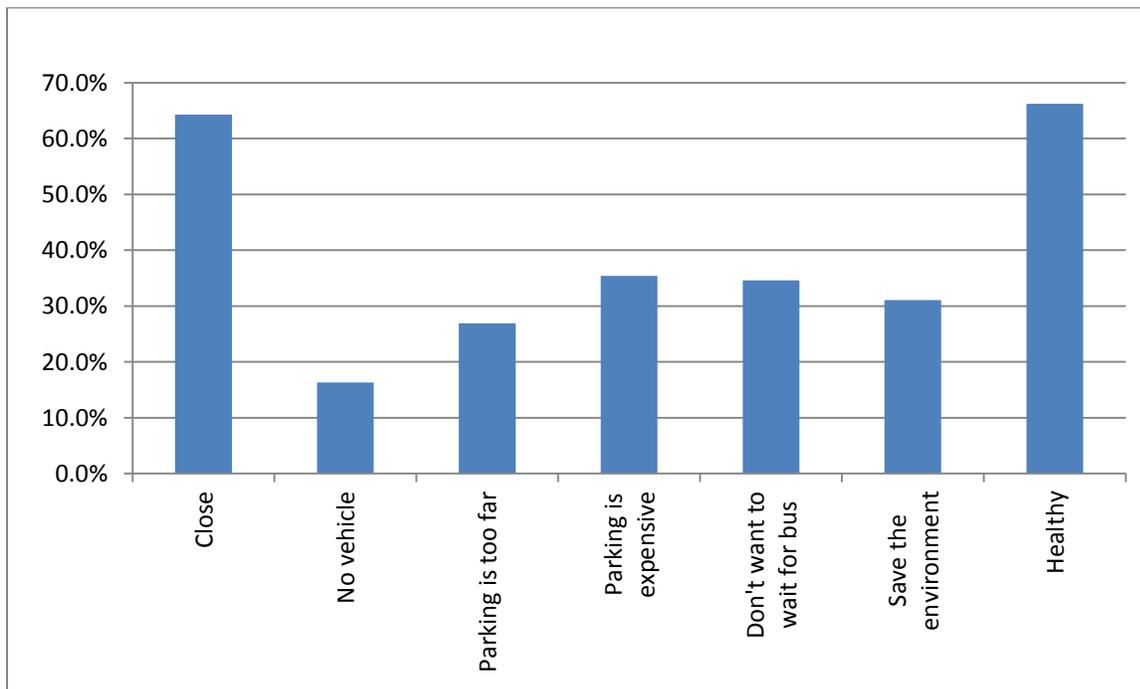


The only significantly-growing travel mode in the past few years is riding bicycles. Bicycle ridership has increased 24% from 2010 to 2011, 79% from 2011 to 2012, and 122% from 2010 to 2012. At the

same time, the mode share of driving alone has dropped 34.4% from 2010 to 2012. Other increased travel modes include walking and other modes. Carpool, transit, and motorcycle's mode shares have been fluctuated.

The survey for Bike Share Program contains more questions, which revealed the characteristics of travel behavior on campus. According to this survey, 66.2% of people biking to school were because they think riding bike is healthy. There is 64.3% of people chose bike because they lived close to campus. It is interesting that even though expense was not a choice in this "why do you bike to school" question, many people indicate that in their comment.

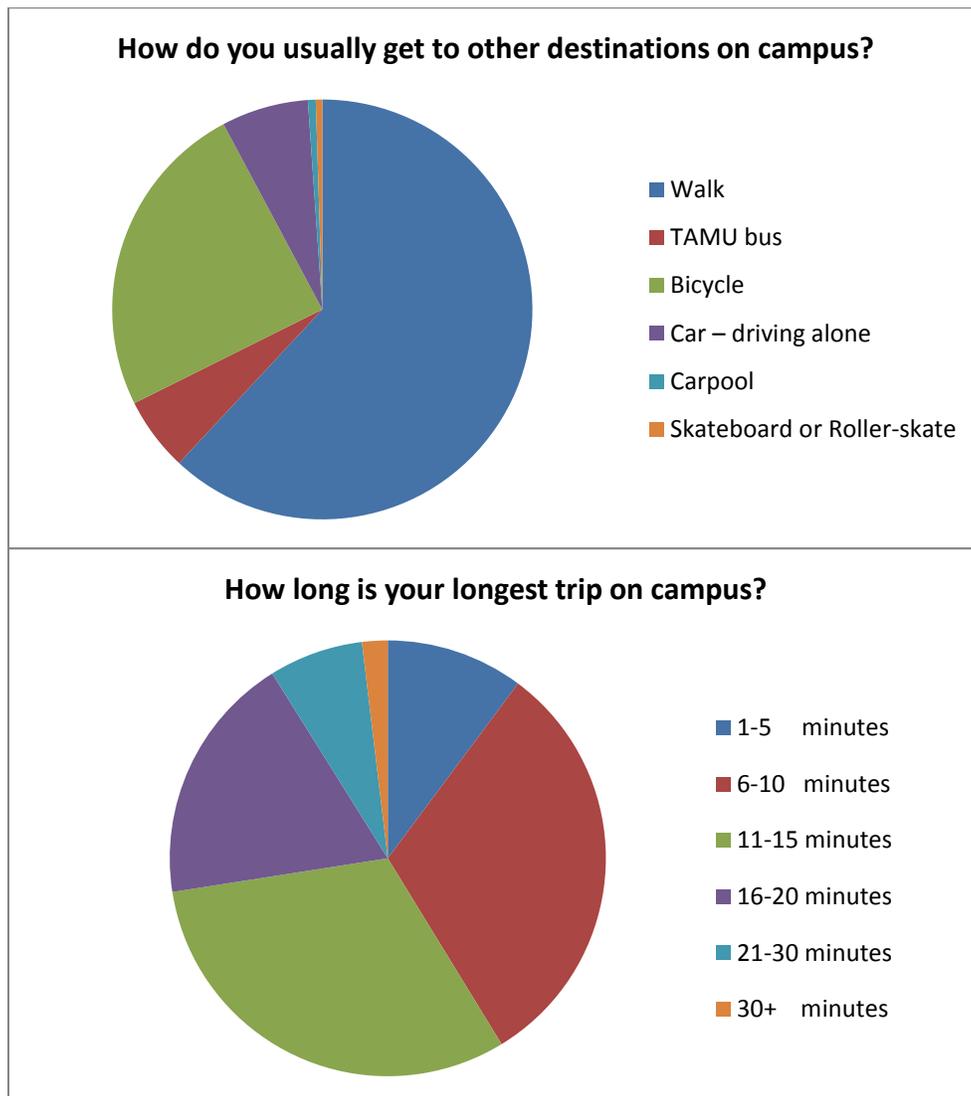
Figure 2 Reason of Bike to School (Bike Share Program Survey, 2012)



It is not convenient to drive around campus due to the limitation of parking permit, therefore people prefer to choose non-motorized travel mode. Hence, once people arrived at campus, more than half

of them would choose walking as a way to travel around campus. The percentage of biking on campus is almost the same as the percentage of people biking to school. Those people who have a bike would still like to choose bike to go around on campus. Also, the longest trips on campus normally range from 5-15 minutes.

Figure 3. Travel Mode and Travel Time on Campus (Bike Share Program Survey, 2012)



The question "For what reasons would you want to join a bike share program on campus? (Check all that apply)" explained why people

wanted to ride on campus if they have access to bike. 68.7% of the people wanted to join the Bike Share Program because they think their walking distance is more suitable for bicycling and 60.1% of them stated they like bicycling. Another question: “which improvement would make you reconsider joining the bike share program? (Check all that apply)” relates to the improvements on campus that would benefit cyclists and potential cyclists. Designating bike lanes received the highest rank (62.8%) out of all other choices. This score is even much higher than “good quality bike share service”, which was the only choice related to Bike Share Program itself. The existence and quality of bike lanes is considered as a crucial attractive element.

Figure 4 Reasons for join a bike share program (Bike Share Program Survey, 2012)

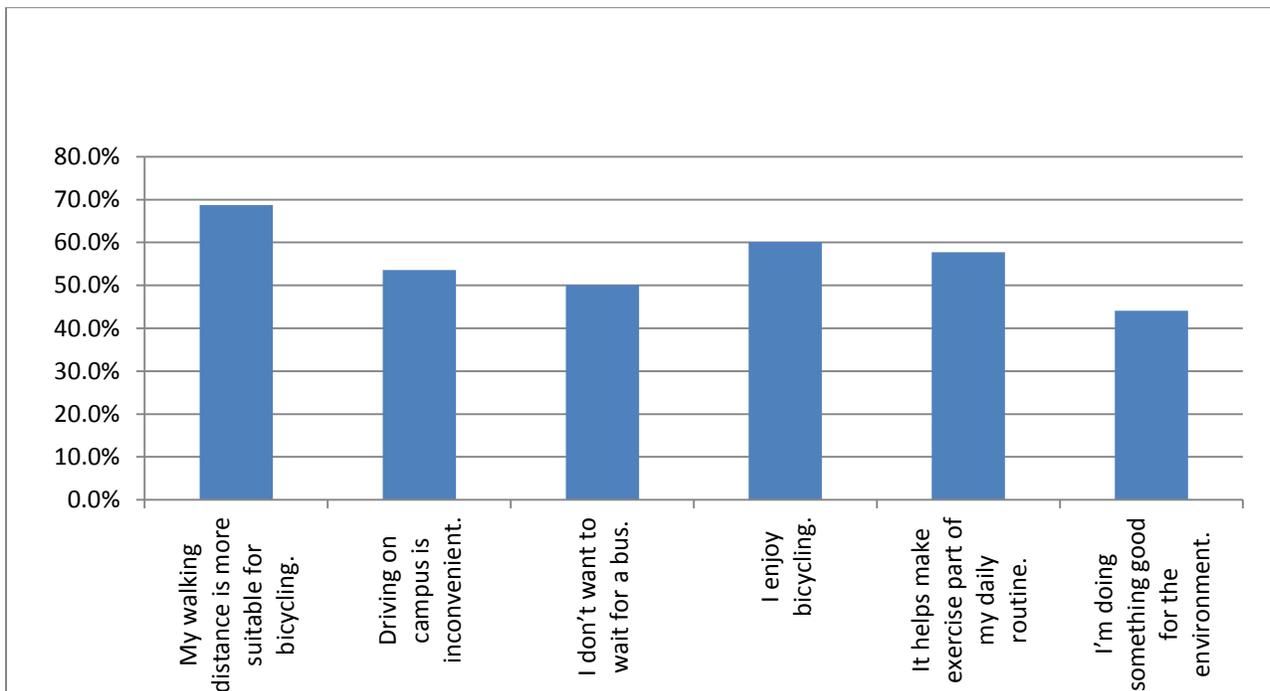
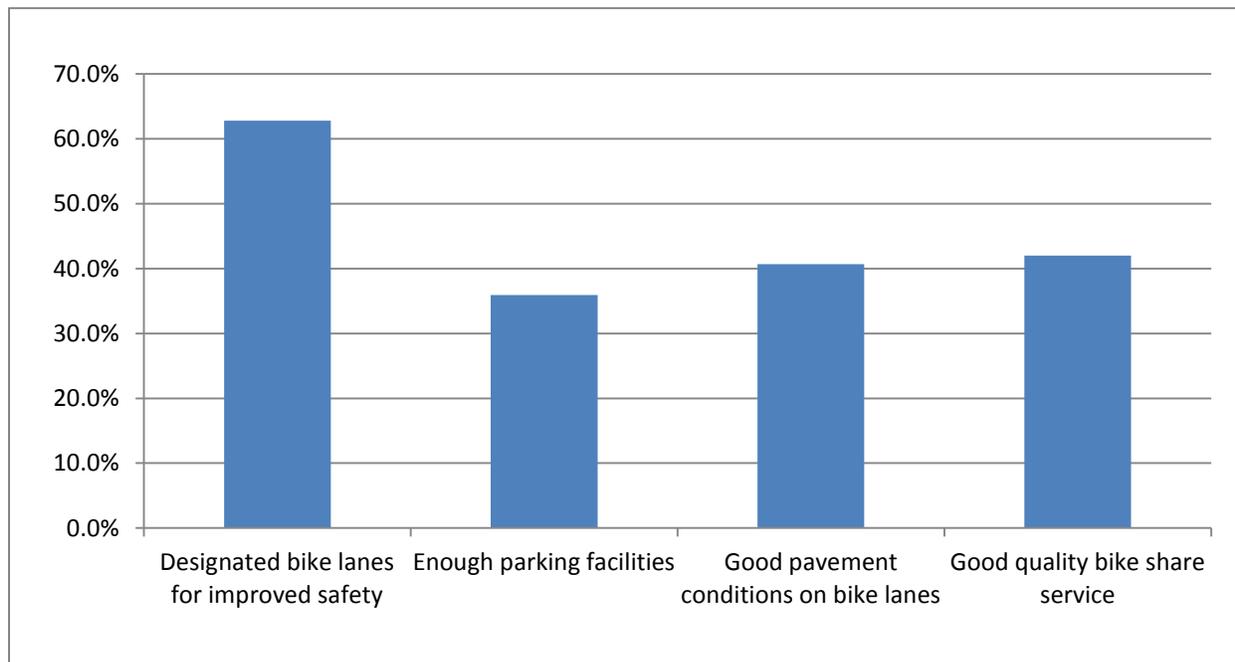


Figure 5 Improvements that will make people joint Bike Share Program (Bike Share Program Survey, 2012)



The results of the campus survey can be summarized by the following:

- 1. The bike ridership of Texas A&M University has been increasing. From the trend of growth, we can see that there is large potential for TAMU to develop a bigger bicycle system and build a healthier and more environmentally-friendly campus.**
- 2. In TAMU, students, faculty, and staff are all willing to use the bicycles. They care about the environment and their health issue. Also, their commute distance makes it feasible to ride bicycles.**
- 3. Improvements on bike lanes will be an efficient approach to attract people to ride their bicycles on campus.**

Current Cycling Environment on Campus

Bike Suitability Assessment

Bike suitability assessment is an approach to mathematically and visually measure the cycling environment on campus in terms of street conditions. By doing so, each factor that might influence the travel behavior is recorded and expressed and a more convincing analysis could be conducted.

Site Survey

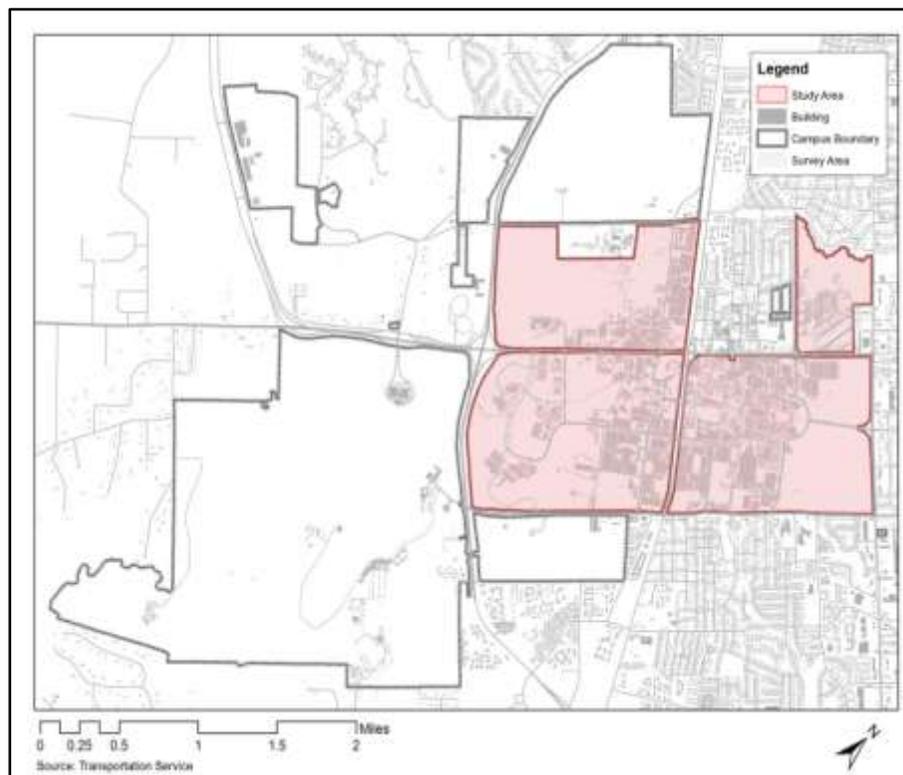
The campus of Texas A&M University is fairly large. This study chose part of the campus (Figure 6) as the study area. This area includes most part of main campus and west campus, as well as University Apartment Area. The total area acreage is about 2098.69 acres. The reasons for choosing this study area are:

- 1.The study area includes main campus and west campus, which has the highest density of buildings. The buildings that are most frequently used by students are located here.**
- 2.This area includes all the bike routes that have already built on campus.**
- 3.Almost all the on-campus bus routes and bus stops are within this study area, except part of route 02. This route runs to Texas A&M Health Science Center to the west of main campus.**
- 4.Most of the students' activities happen in this area. Memorial Student Center, Kyle Field, Recreation Center, George Bush Library, etc. are all located here.**

5. This area includes all the on-campus students living area, the two major residential halls and University Apartments.

6. The on-campus bus stops for off-campus bus routes are all located in this area. Additionally, this area has over 96% parking lots and garages. This indicated that most people that live off-campus start their activities on campus from this area.

Figure 6 Study Area



METHODOLOGY

Site Survey

Many research studies have developed their own criteria for bicycle suitability. Three typical assessment systems were concluded by Turner, Shafer, and Stewart (1997):

1. Stress level: This criterion is basically measuring the stress from automobiles on bicycles. It only collects the data for vehicle speeds, vehicle volumes, and curbs lane widths. It is simple and easy to manipulate. Since it does not include all the “hypothesized” factors, the result will be objective. However, for the same reason that some of the factors that might influence the cycling behavior are not included, this measurement might be less comprehensive. (Turner et al., 1997)

2. Road way condition based: this type of assessment is based on the condition of roadways. The variables for different assessment would vary a lot depending on the purpose of the assessment. Except the factors that are used in the first stress level assessment, this type of assessment also wants to know the effect from pavement and location.

3. Capacity based: this criterion is more technically defined and more rely on mathematical method to obtain the level of service for bikeways.

Based on previous literatures (Emery & Crump, 2003; Turner et al., 1997) the checklist was composed of criteria based upon how the build environment affects bike suitability. It seeks to explain the current situation of TAMU campus’ roadway condition and design, condition of bike lanes, sidewalks and tries to figure out the influences from other transportation modes. Meanwhile, since the land use of the whole campus area stays consistent, the factors that relate to land use are excluded in this checklist. Factors are separated into “location factors” and “pavement factors”; each factor has a negative or positive effect on bikeability. The description of each factor is listed in Table 1.

Table 1 Description of Site Survey Variables

A) Location Factors	Effect	Note
1) Center (Both) Turn Lane	Positive	Gather the automobiles in the middle of the streets to avoid the potential conflicts with bicycles.
2) Physical Median	Positive	Separate the traffic and give bicycles a buffer zone to relieve the pressure of crossing the streets
3) Paved Shoulder	Positive	Paved shoulders are normally considered as a designated area for bicycles. They can separate bicycles with automobiles and increase the awareness of automobiles drivers. Cyclists' feeling of safety will be enhanced.
4) Marked Bike Lane	Positive	Major reasons are same as paved shoulder. However, marked bike lanes are better than paved shoulder because they are marked by clearer pavement and signs.
5) Paved Shoulder on one side	Positive	It is a positive, however worse than paved shoulder on both sides.
6) Restricted Road	Positive	This type of road only allows permitted vehicles to drive through, which restricts large amount of vehicle traffic and decreases travel speed. There will be less stress from automobiles on bicycles.
7) One Way Street	Positive	Reduce the traffic volume. The direction of vehicles is predictable.
8) Bike lane with signage	Positive	Signs also help to increase drivers' caution. At the same time, they give a guide to cyclists.

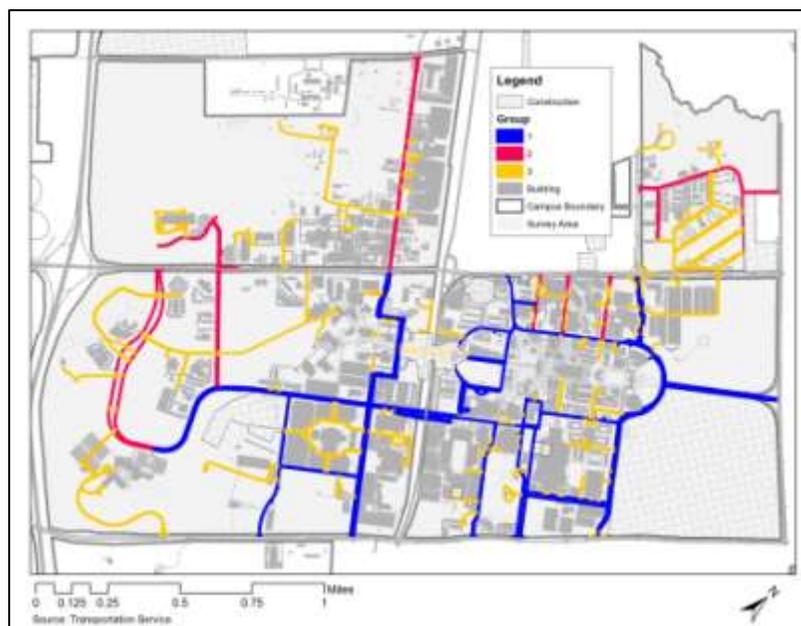
9) Bike lane with shade	Positive	Tree canopy can protect cyclists from sunlight. This is useful for cities that experience hot weather in summer. It increases the comfort and enhances people's willingness to use bicycles.
10) Angle Parking	Negative	The effects that parking on the side of the road might cause include: the occupation of road and the conflicts with both bikeways and bicycle traffic flow.
11) Parallel Parking	Negative	Same as above
12) Right-Only Turn Lane	Negative	Conflicts between automobiles and bicycles will happen when bicycles are trying to go cross the street or turn right.
13) Difficult Intersections	Negative	The intersections that are difficult to cross because of lack of crosswalk or other impediment are "critically negative". Intersections are always relatively dangerous spots in a road system. Because of this, it is easy for an inexperienced cyclist to make mistakes at these locations.
14) Sidewalk do not exist	Negative	Sidewalk can increase the caution of drivers. It alerts them that there are other forms of transportation might occur on the road. Though, in order to avoid the conflicts between cyclists and pedestrians, cyclists are not encouraged to ride on the sidewalk if bike lane exists, sidewalk can still help to reduce the danger.
15) Sidewalk Only One Side	Negative	One-side sidewalk is better than no sidewalk. However, it has some of the same problems as above. It has less negative influence.

B) Pavement Factors	Effect	Score for "Yes"
1) Pavement <p style="text-align: center;"> Very Good Good Fair Poor Very Poor </p>	 	<ul style="list-style-type: none"> • Only new or newly-paved roads are smooth enough to be considered as very good. • Road in a good condition should be relatively smooth and have does not have many crack or uneven pavement. • Fair roads are those roads that cracks and uneven pavement are easily observed. • Poor condition roads should have louse pavement that even affect the speed of automobiles. • Very poor pavement will have distress on 75% or more of the surface.
2) Presence of a Curb	Negative	Curbs can act as an obstacle and disrupt bicycle traffic flow, especially for un-experienced cyclist.
3) Rough RR Crossing	Negative	Rail road cause unexpected interruption and uneven road.
4) Storm Drain Grate	Negative	There are two concerns about storm drain grates: one is that it is easy for bike tires to stuck in the cracks of grates; the other one is that the storm drain grates usually cause a huge depression of the road pavement, which might cause some safety issue.

This site survey was mainly conducted during Feb. 3rd to Feb. 16, 2013. After that, some small site visits happened because of missing of data. Roads within study area are categorized into three groups:

1. Roads indicated by Transportation Service in Bicycle Lanes map ("Bicycle Lanes," 2013) that bike lanes existed. The data was primarily collected by site observation. Author travelled on these roads by bicycle in order to have a direct feeling about the surface of the roads, safety, and comfort.
2. Roads that are not marked as bike lanes, but are major connection arterials on campus. This group of data was collected by driving along the roads.
3. Roads that have neither bike lanes, nor major connections. These roads are normally cul-de-sacs or have particular usage, such as the entrance to buildings. Those roads were excluded in this site survey since they do not have typical characteristics.

Figure 7 Survey Road Group



GIS Analysis

ArcGIS 10.0 was used for the final analysis. The reason for using GIS to run the analysis is because GIS can combine the attributes of

roads with their geographic information. It is a more direct way to understand and interpret the data, especially when the data is location-related. Another advantage of ArcGIS is it can integrate with many other databases very well, so that users can easily manipulate the data.

All the data was stored in a geo-database as a shape file that has all the geo-information associated. The geographic information is provided by Texas A&M Transportation Service. Each road has the attributes that correspond to each factor. This dataset uses 1 and 0 to represent yes and no. For a certain road, the elements that were checked as yes would be assigned a value of 1 in the corresponding cell. Finally, the overall score was calculated based on the each observation being weighted as its significance of influencing travel behavior.

Limitations

There are some limitations in this assessment method due to the lack of data and flaw of methodology.

- **Due to the lack of time and equipment. The data about general road factors was not collected. Those factors include but not limited to Annual Avg. Daily Traffic (AADT), outside lane width, and bike lane or paved shoulder width. Fortunately, there is relatively not too much traffic pressure on campus. The speed limits on campus are all less than 40 mph and the largest roads have 4 lanes. In addition, there is no traffic light within study area. Automobiles on campus travel in a low speed and the traffic volume is relatively low. Therefore, the study result would not skew too much. However, for**

further investigation, to conduct a more comprehensive study, it is better to have those factors included.

- The score calculation method has some flaws. This calculation is simply based on the sum of every factor; however, the influence of each factor is not exclusive. They have effects on each other. For example, if a road is one-way with two sides of sidewalks, this road will get a high score in this evaluation system since those two factors are both positive. In reality, contra-flow bike lanes are not recommended. For this type of roads, automobiles will be driving adjacent to bicycles that travel in two completely opposite directions. This increases the possibility of collision and enhances some cyclists' concerns about safety.

- This evaluation is not entirely objective. The bias of the observer might influence the result. Some of the factors in the list are matter of fact; every person will give the same score for them, such as angle parking or paved shoulder. Those are the factors that measure the quantity. There are some other factors that relate to the quality of the road, for which different people might give distinct scores. For example, it is difficult to strictly define the pavement level. A road that is evaluated as "good" might be just in a "fair" condition in some other people's opinion.

RESULTS

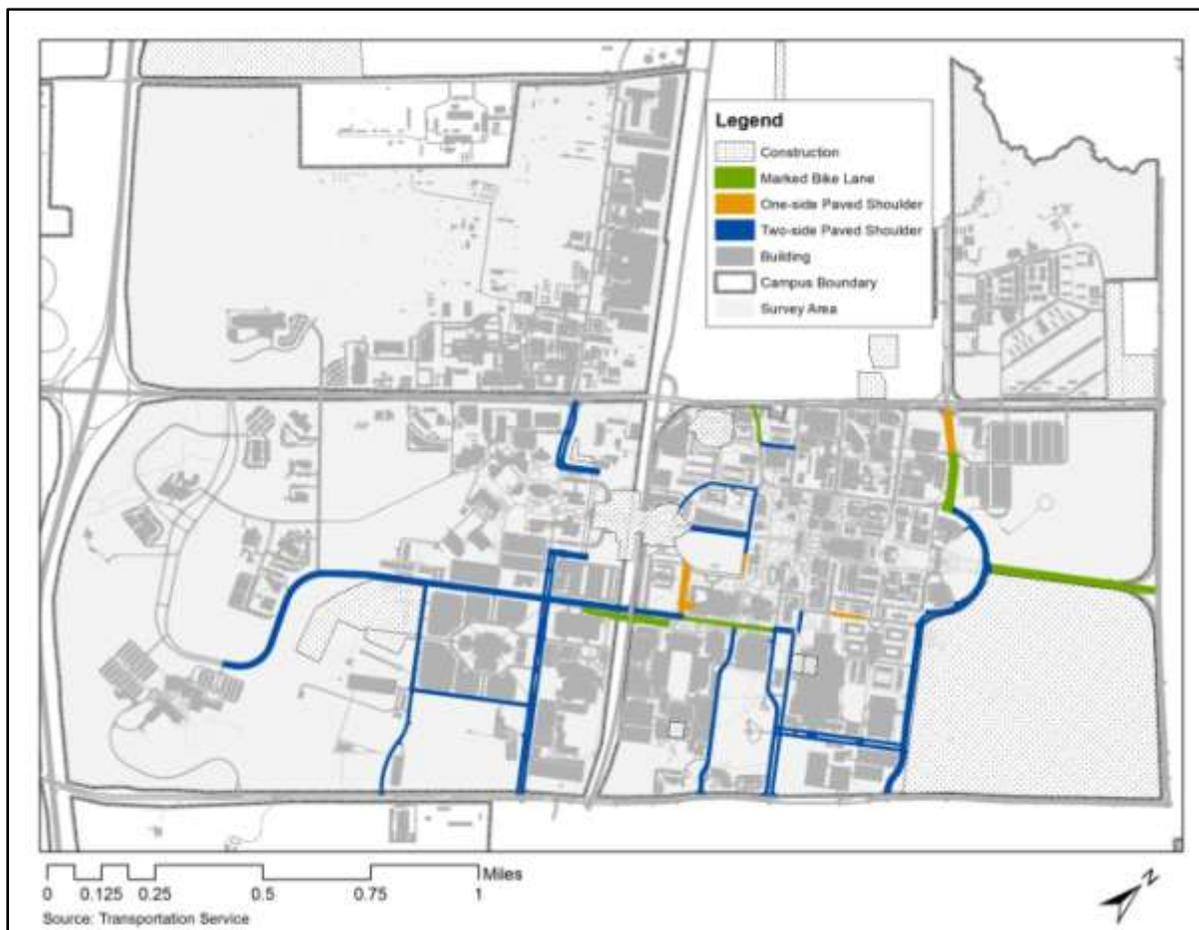
Bikeway System

Like roads and sidewalks, bikeways on campus provide connections to different area. The bikeway network should be connective. Users that are using the network should be able to reach their destination without obvious obstacles. Texas A&M campus has a relative

extensive bikeway network. The university has very few bike use restrictions, which provide a friendly cycling environment.

In terms of the existence and quality of bike lanes, bikeways on campus can be separated into four groups: bikeways with marked bike lane, bikeways with paved shoulders on both sides, bikeways with paved shoulder in one side, and bikeways without bike lane. Of all the roads that are within the study area, 2% are under construction, 36% have either paved shoulders or marked bike lanes. 84% of those bikeways have paved shoulder on both sides. There are only four street segments that have the marked bike lanes; they are marked in green in Figure 8.

Figure 8 Existence of Bike Lane/Paved Shoulder



If we classify the bikeways by usage restrictions of different travel modes, there are three types of bikeways.

- **Separated, bike-only path:** these are the paths that designated for bike/pedestrian only. Bike lanes and pedestrian paths are usually parallel to each other. This type of bikeway provides a safer environment for both cycling and walking. Also, they are normally major connections between different areas. There are two segments that can be considered as bike-only path.

-Under pass in Wellborn Road. This is an important arterial to connect west campus and main campus for bikes and pedestrians. Wellborn is a north-south major road of College Station. It cut through TAMU campus and set a physical barrier between main campus and west campus. There is a rail road parallel to Wellborn Road. By providing the grade separation, this under pass helps to avoid the potential conflicts between bikes/ped and both heavy traffic and trains. As west campus garage, REC center etc. are on the west, KyIe field and MSC are on the east side of the road, this under pass carries a lot of bike/ped traffic, especially in football game days,. Bike lanes are marked on two sides and pedestrians can walk in the middle of the road.

-Bike path in front of post office, North Houston Street. This bike-only path directly connects to the new-built bike-only path in North Gate district. North Gate is a central entertainment area for both university and the city. This bike path gives people on campus a safe and convenient access to many bars and restaurants. The bike path has marked bike lanes in the middle and sidewalks on two sides of the road. Trees are planted along the street, which give the bike path shield with green feelings.

●**Bikeway Street:** these are roadways that bikes need to share roads with automobiles but closed to provide access to only school buses and permitted campus vehicles. Roads are usually closed from 6:00 am to 6:00 pm on weekdays. They are located at active campus areas.

-**Joe Routh Blvd to the south of MSC.** This is a newly-paved road with the renovation of MSC. This bikeway is well paved with clear signs and road markings. Only buses are allowed to drive on this road.

-**East part of Ross Street.** This street is the major road segment in the center of main campus. It is a connection of many teaching buildings. This is also the closest roadway that could connect to library from the north. Buses and permitted vehicles are allowed to use this road.

-**Area in front of Sabisa Dining Hall.** This is a busy area as an intersection of three roads. Also, there are various activities going on at the plaza in front of Sabisa. In addition, this area connects to the military walk, a park-like green corridor. However, roads in this area do not have any paved shoulder or bike lane.

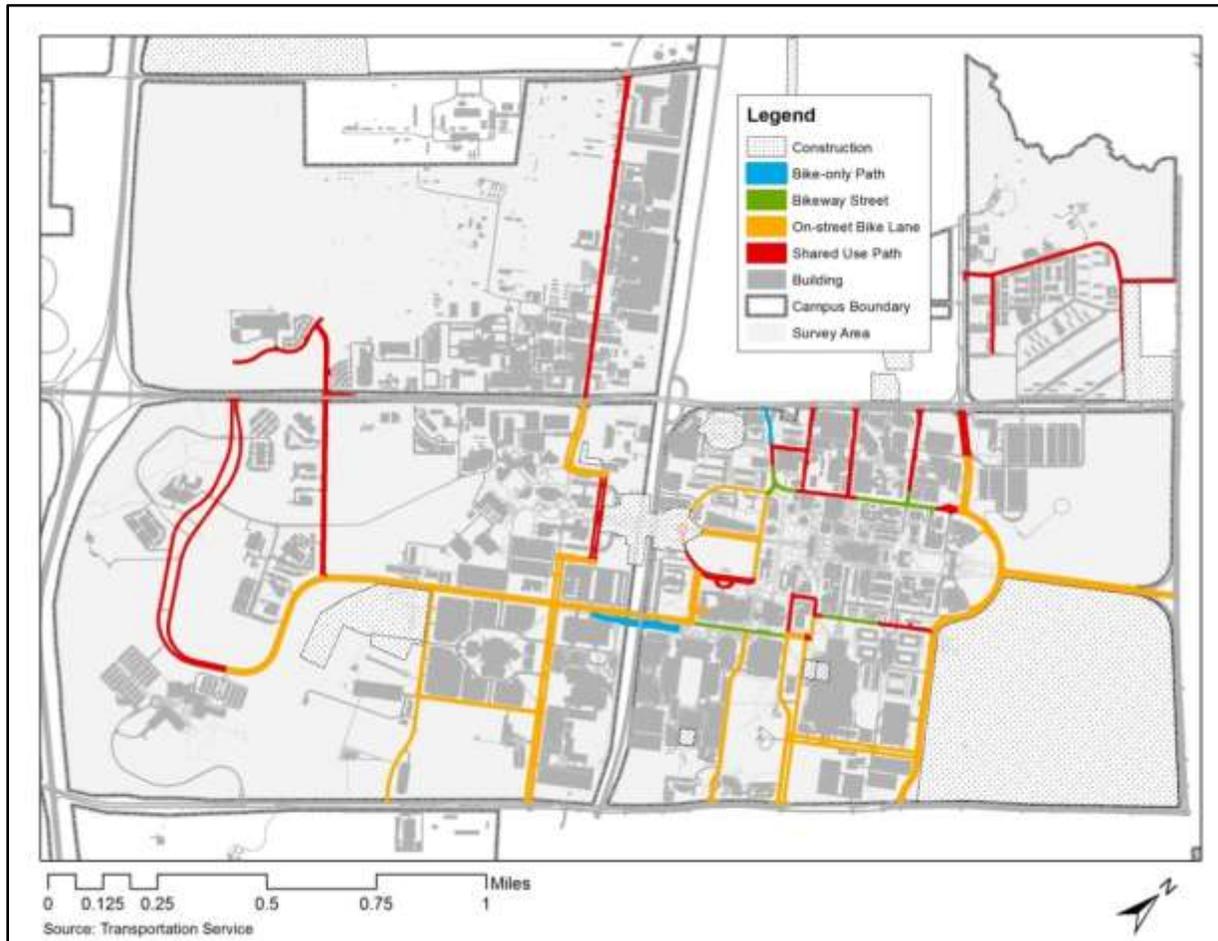
-**Lubbock Street.** This is a road that is in front of residential halls. It provides the connection for students living on campus to other parts of the campus. But there is no bike lane provided.

●**On-street bike lanes.** Bike lanes or paved shoulders are provided in these streets. Other vehicles can also use those roads at any time without any restrictions. Cyclists have their own dedicated

area to ride bikes and do not need to worry about the conflicts with pedestrians or automobiles.

●**Shared-use path.** In this type of bikeways, bicycles are supposed to share roads with either automobiles or pedestrians. However, bicycles are usually not welcomed to use neither sidewalks nor automobile lanes and conflicts between them are easy to happen. Hence, these bikeways provide for shorter, low-speed internal campus trips.

Figure 9 Bikeway Classification



Signage



Figure 10 Bike signage on campus

Signs are critical but often overlooked elements in bike system. They give directions and instructions to cyclists such as telling cyclists where they can or cannot ride bikes. In addition, they give alerts to automobile drivers that there might be bicycles riding on this road, which will increase their caution. Adding signage is a way to improve the road safety and organize the road.



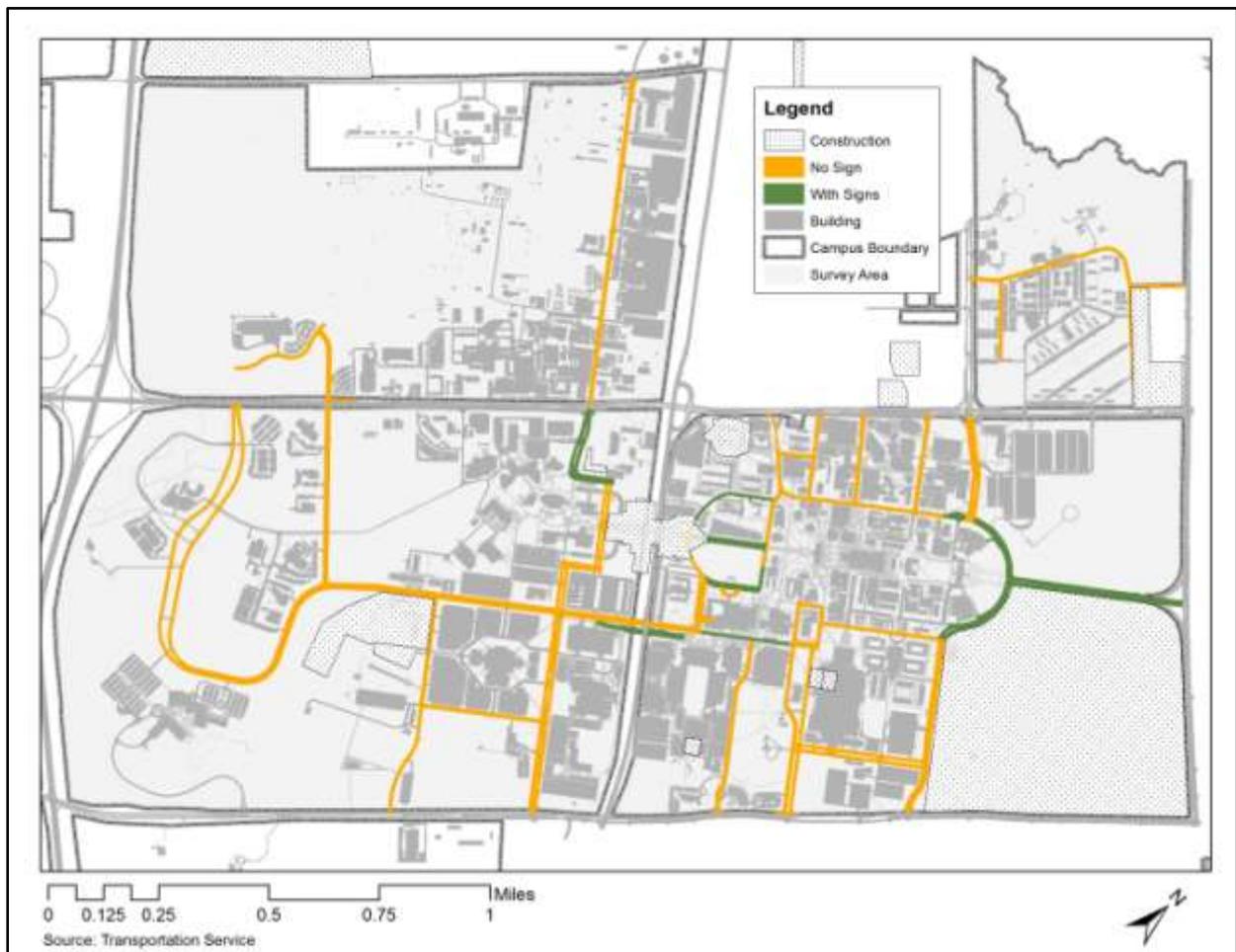
Figure 11 It is difficult for drivers to tell the bike lane sign from about 35 yards away

There are some good signs on campus, for example, signs on the bikeway street in front of MSC, they are clear and outstanding. However, bike signage in Texas A&M University is deficient

compared to the whole bikeway system. Less than 10% of the streets have bike signs. Even though some of the roads have bike signage, there is only one sign for a whole road segment that is about a quarter mile long, for example, Olson Blvd.

In addition to that, the style of bike signs needs to be improved. Currently the bike signs have four lines of words with green background. They are very difficult to read, when people are in their vehicles. No matter they are bikes or automobiles, drivers or cyclists pass by those signs very quick. In addition, green does not contrast with white enough to make the words stand out.

Figure 12 Bike Signage



Pavement

Most of the streets on campus are in a relatively good condition, especially those new paved streets, for example, Joe Routt Blvd and Ross St. However, bad pavements also exist on campus. Roads with cracks or uneven pavement can be easily found. This might bring an unpleasant cycling experience to cyclists and discourage potential cyclists to ride their bikes.

Another problem with current streets is the existence of storm drain grate. Those storm drain grates bring unexpected fluctuant surface when cycling that can be unsettling. And it is easy for un-experienced cyclists to face safety issue.

Suitability

Based on the data collected from site survey and analysis above, a suitability analysis was conducted using ArcGIS. The result is showed in Map 6. The suitability comparison is based on relative score. We can see that the most suitable bikeways are the bike-only paths and bikeway streets. These are the roads that have the most positive influence on bike suitability. For example, they have marked bike lanes instead of paved shoulders. Most of them are restricted roads so that the chance of having conflicts with other forms of transportation is reduced. Bike signage is also another important element that makes those streets become bike-friendly. Also, all those streets that received good scores have relatively good pavement conditions.

The roads that are least suitable for bicycles are those roads without signage and bike lanes or paved shoulders, have on-street parking, and have bad pavements. Those are the roads that need to be

improved to enhance the connectivity of overall bikeway network and to build a more bike-friendly campus.

Figure 13 Bike Suitability



Other Bicycle Facilities

Bicycle parking

During 2011-2012, Transportation Service has been installing and expanding bicycle parking facilities. Take only 2012 as an example, 220 bike racks have been installed in fiscal year of 2012. Bike parking is relatively sufficient.

Rack type

There are some major types of bike racks that are used in TAMU campus. More rack types might exist on campus, especially those newly-developing areas.



Semi-toast: this type of racks is using two loops to hold the wheels. Even though racks that not provide support for bike frames are not recommended, (APBP, 2002) this is still one of the most commonly found bike racks on campus. They are representatives of old-fashioned bike racks.



Triangle: this is another type of racks that are easily found on campus. One rack element can support at least two bicycles. They can support U-lock and they are efficient.



Inverted "U": one rack element support two bicycles. This type of racks is more commonly used for newly-installed bike racks.



Wave: we can rarely find this type of racks on campus because it requires specific shape of parking area. This type of racks is usually utilized less than their actual capacity.



Comb: another type of racks that is usually under-utilized. The reason the under-utilization is partly because cyclists are not familiar with using it.



Square: one rack element should be able to support two bicycles. New and rarely-found type.

Figure 14 Types of Bike Racks

According to site observation, the most popular rack type on TAMU campus is triangle. They are usually used in those areas with high bicycle parking demand.

Occupancy

Typically, occupancy of bike racks is range from 40%-70%. Yet, this number varies depending on location and time. There are some places, for example, MSC, Trigon, and West Campus Garage that parking spots are always difficult to find, even though parking capacity at those places is the largest among campus. Insufficient parking spaces leads to disordered bicycle parking.



Figure 15 Displacement of bikes on campus

Sheltered Bike Parking

There is no freestanding shelter structure exists on-campus. However, some of the buildings are utilized to provide sheltered bicycle parking, for example, West Campus Garage and Langford Building. These sheltered parking spaces help to prevent bicycle damage from weather.



Figure 16 Sheltered bike parking

Dismount Zone

With the opening of the MSC/Rudder Plaza area, dismount zones for bikes and skateboards are being added in order to promote a safe environment in those busy areas of campus. Several more dismount zones continually being placed after that. It is difficult and unsafe to ride bikes in a place that many activities are happening there. Pedestrians always choose random



Figure 17 Dismount zone

routes since they assume that no other transportation forms will enter this area. Cyclists are required to pay attention to dismount zones. Riding bicycles and skate boards are prohibited in those areas.

Bike Maintenance Stations

Bike maintenance stations provide tools and air pump to any cyclists on campus for free. With this accommodate bike facilities, cyclists would not need to worry too much about flat-tire and small operating issues of their bikes. Bike maintenance stations and their signs are also another type of campaign for bicycle use. They are like commercials for an insurance company, constantly reminding you that you will always have back-up if you need it, all you need to do is riding your bicycle.

SUGGESTIONS FOR IMPROVEMENTS

In order to enhance the connectivity of bikeway system and enhance the safety of cycling, some improvements need to be implemented on campus.

Previous Improvements

Improving the bicycle facilities is an efficient way to attract more people to become cyclists. As we discussed above, according to the survey result, the bicycle mode share has increased significantly from 2011 to 2012. Part of the reasons for this change is that some efforts were made for the improvements of bike facilities in this time period. Improvement included but not limited to:

- Adding new bike parking racks. In FY 2012, the Alternative Transportation Unit installed 220 bike racks on campus, along with expansion and replacement. Installation area include: Kleberg, Halbouty, the Rec, MSC, Zachery and many others.**
- Building new bikeways. During 2011 to 2012, some new bike-friendly path finished construction, including Joe Routt Blvd, the bike way street on the south of MSC.**
- Updating the bike signs. Some way-finding and bike lane signage were updated on campus. For example, the signage at the under pass.**

Figure 18 Previous Improvement of Signs

Before

After



The improvements that have been done in the past few years made a lot of achievements. They promoted a safer and friendlier bicycle environment and brought more cyclists on campus. However, improvement is not a short-term task. Along with the

development of campus construction and the growth of population, different types of improvements should be taken.

The improvements that are suggested in this paper mainly focus on bikeway facilities; include bike lanes, signage and pavement.

Improvement of Bike Lanes

Bike lane, acts as guidance on the road, leads the direction for cyclists; reduces the conflicts between different forms of transportation; and increases the caution of motorists. The connectivity of the overall bikeway network is not adequate enough. More bike lanes need to be added. Adding new bike lanes is suggested to the following streets:

- **Houston St., the segment at the intersection on the west side of Sbisa**
- **Ross St.**
- **Asbury St.**
- **Ireland St.**
- **Spence St.**
- **Lamar St. West**
- **Lubbock St.**
- **Coke St.**
- **Lamar St. Central**
- **Throckmorton St.**

Roads that need to improve or repaint bike lanes (roads with only one-side paved shoulder currently):

- **Houston St., from Beutel Health Center to MSC**
- **Gene Stalling Bl.**
- **Bizzell St.**

Schedule of Improvements

The implementation of improvements suggested in this paper will depend on actual economic condition and future development. The schedule of improvements proposed here is based on suitability score, as well as connectivity and accessibility.

Short term

Improvements that should take place in recent 1-2 years include:

- **Houston St., from Beutel Health Center to MSC. For the short-term strategy, the bike lanes of this street could be just simply repainted. However, alternatives described as following are highly recommended.**
- **Bizzell St., north part, in front of Emerging Technologies Building. This road connects to the University Apartments. Currently, the bike lane for Bizzell St. ends at the intersection of Bizzell St. and Polo Rd. Adding bike lane here will help to improve the connectivity.**
- **Central Larmar St. This is the street pass through Trigon, one of the busiest areas for bus stops.**
- **Place begin and end signage for bike lanes.**

Medium term

Improvements that should take place in 2-5 years include:

- **Olsen Blvd. Bike lane is missing at the middle part of this road. After the accomplishment of the new underpass project, higher volume of bike and pedestrian will be brought to this road. Bike lane will be needed.**
- **West Larmar St., in front of MSC. Treatments could be chosen from the following recommendation.**

- **North Spence Street.** After the new student apartments (Stack) begin to be used, this road will have more bike traffic. Improvement needs to be made by then.
- **New bike signage should be placed.**

Long term

After the improvements listed above being implemented, other improvements could be scheduled. We should also notice that the development of bike facilities is not only about building new facilities, but also maintaining the existing facilities. The maintenance should also be scheduled while building the new infrastructure.

General Design Guideline

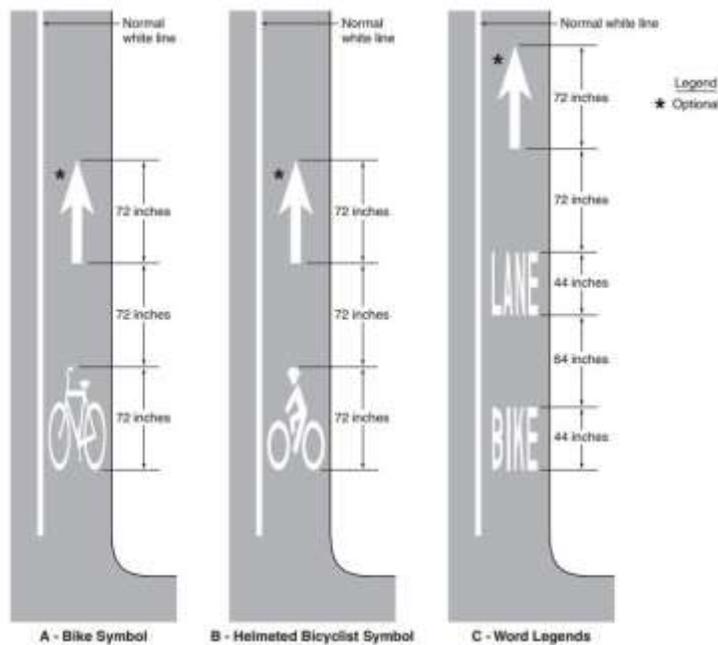
For most of the roads, the improvement will just be adding conventional bike lanes. The design guidelines are showed as below. Roads that are suitable for these guide lines are the ones with curb and gutter and have no street parking.

- **A solid white line should be used to separate the automobiles and bikes. "A bike lane should be delineated from the motor vehicle travel lanes with a 150-mm (6-inch) solid white line. Some jurisdictions have used a 200-mm (8-inch) line for added distinction." (AASHTO, 1999) For roads on campus, where we are not facing too heavy traffic, 6 inch line marking is normally enough**
- **As AASHTO (1999) recommended, the minimum rideable surface from bike line marking to the edge of the street should be at least 3 feet, however, 4 feet is desirable. If street parking is prohibited, the width of minimum 5-foot bike lane should be provided for streets with curb and gutter and 6 feet is**

desirable. This should be applicable to the roads we proposed, yet without street parking.

- Pavement markings for bike lanes are highly recommended. *“If used, bicycle lane word, symbol, and/or arrow markings should be placed at the beginning of a bicycle lane and at periodic intervals along the bicycle lane based on engineering judgment.”(FHWA, 2009b)* Examples are showed in Figure 19.

Figure 19 Word, Symbol, and Arrow Pavement Markings for Bicycle Lane (FHWA, 2009b)



Special Treatments

There are some roads will need more than just adding a bike lane to fix the problem. Special treatments should be applied to improve the safety and promote multi-modal transportation.

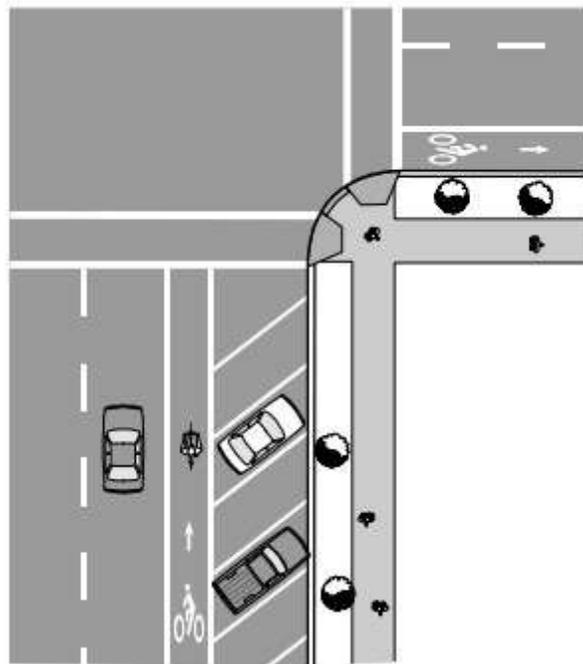
Streets with on-street parking

These streets include: **Asbury St., Ireland St., Spence St. and Gene Stallings Blvd.** Since the vision for drivers is bad when cars are backing out the parking spots, on-street parking can

easily cause conflicts between cars and bikes. Bike lanes and on-street parking are usually not encouraged to place next to each other (FHWA, 2009a). But in order to keep consistency with the overall bikeway network, streets with on-street parking should be added bike lanes.

- Bike lane should be parallel to the street and to the left of parking area.
- The parking area should be wide enough to accommodate most vehicles.
- An 8-inch line marking should be used to separate parking area and bike lanes.
- Provisions should be made to prevent vehicles using bike lanes (FHWA, 2009a).

Figure 20 Design of Bike Lane and Angle Parking (FHWA, 2009a)



One-way Streets

There are several one-way streets on-campus. Currently, different treatments for bicycle traffic flow are used on those streets. For

example, Houston St. on the north side of Old Main has two-side paved shoulder, without any special markings for contra-flow bicycles; Houston St. on the south side of Old Main, only have paved shoulder on one side; and West Lamar St. and Central Lamar St. do not have any bike lane or paved shoulder. No bike signage is provided for those paved shoulders in opposite direction. This will cause some confusion to cyclists. Uncertainty about legality and safety of riding on these streets will prevent cyclists from using them. Also, the possibility of conflicts between automobiles and bikes that travel in opposite directions is largely increased if sufficient signs and road markings were not provided. Promoting cohesive treatments for those one-way streets will be beneficial.

Alternative 1: keep one-way streets as "one-way" for bicycles.

Keeping bicycle traffic flow in the same direction as automobile traffic flow is the simplest approach to avoid the conflicts on one-way streets. However, this will elongate the travel distance of the bicycles that need to travel in the opposite direction. Cyclist might finally either choose another route or ride in the sidewalks.

Some requirements need to be followed if this alternative was chosen to be implemented.

- Bike lane making and pavement needs to follow the general design guide line.
- All the existing paved shoulders should be removed.
- Specific signage should be installed. For example, "wrong way" sign in the left side of the road towards the contra-flow traffic.

Alternative 2: Contra-flow bike lanes.

“Contra-flow bicycle lanes are bicycle lanes designed to allow bicyclists to ride in the opposite direction of motor vehicle traffic.” (NACTO, 2012) This is a solution for creating two-direction traffic in a one-way street. It improves the connectivity of bikeway network, decreases the probability of riding on sidewalks, and reduces the danger of riding in wrong direction. However, this contraflow design introduces new challenge for design and might brings potential conflicts. Design guidelines are listed as follows: (NACTO, 2012)

- **A solid double yellow line is required for contra-flow bike lanes to separate bikes and automobiles. This gives automobile drivers a warning that there is potential on-coming bike traffic and encroaching is not allowed in this streets.**
- **Pavement markings as showed in Figure 19 is highly recommended.**
- **Special signs should be installed. Signs include but not limit to: a “One Way” sign with “Except Bikes” sign should be installed from the begin of the street still the end; a “Do Not Enter” sign with “Except Bikes” sign should be installed facing the contra-flow traffic.**



Figure 21 Example of signs for contra flow bike lanes (FHWA, 2009b)

West Lamar St., segment between Gene Stallings Blvd and Houston St.

This street is also a one way street, however, the treatment for this street should be special because:

- **This street located right in front of MSC, which is one of the most important places for on-campus social activities.**
- **Four types of transportation forms are happening here at the same time: cars can drive in and out without any restriction.**
- **5 transit routes pass by this road with 5 bus stops.**
- **Large amount of cyclists riding their bikes through here even no bike lane exists.**
- **High-volume pedestrian traffic happens every day.**
- **Angled parking is provided in the left side of physical medium.**

Since this is the only access to MSC for most vehicles, though the street is busy, we cannot convert it into restricted road as the normal treatment to other streets that have potential high-volume traffic.

In addition, because of the high volume of automobile, pedestrian, and bus traffic, and the absence of bike lanes, bicycles have highly potential to have conflicts with any of them. Improvement of bikeway design is highly recommended to this area.

Alternative 1: adding conventional bike lanes

Conventional bike lanes are always normally suitable for most cases. People have been familiar with it for a long time, so, confusion rarely exists. It provides separation for different transportation forms and

enhances people's caution. For this particular street, however, conventional bike lanes might cause some safety issues. One is the potential conflict between bicycles and the cars enter or leave MSC by the driveway, as shown in Figure 22.

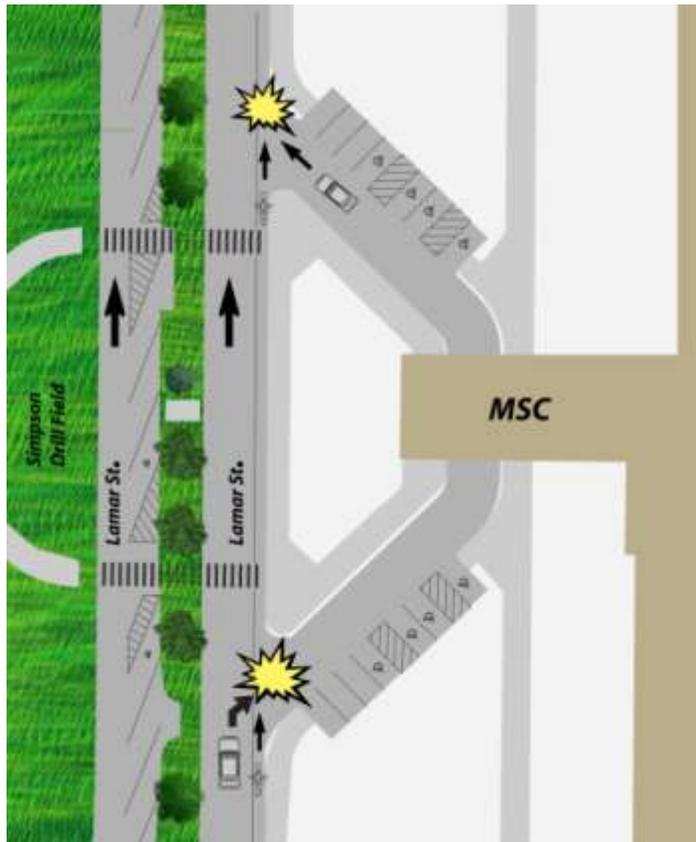


Figure 22 Potential Conflicts between cars and bicycles

Another one is the conflict between bicycles and bus patrons. Bus patrons need to get on and off bus at the right side of the road, which mean they have to go across the bike lane and again, the number of bus patrons here is very large. In addition, it is not uncommon to see buses encroach bike lanes when bike lanes are on the right side. Some design guide lines can help to mitigate those conflicts.

- Follow the general design guideline for bike lane pavement and markings.
- At the intersection of driveway and bike lane, change the solid line to dash line. This indicates that cars are allowed to drive through bike lane and gives cyclists awareness of potential on-coming cars.
- Specific signs should be installed. Signs include but not limit to "Yield To Peds" sign that gives pedestrian the priority to go cross bike lane.
- Bike lane treatment on the left side of the road should keep consistent with one-way street treatment.

Alternative 2: left-side bike lane

"Left-side bike lanes are conventional bike lanes placed on the left side of one-way streets or two-way median divided streets."(NACTO, 2012) Both of the potential conflicts happen at right side of the street. Left-side bike lane will have advantages on right-side conflicts, since it move the bicycle flow to the left side of street. The problem with this treatment is the bike lane transition between left side and right side. Design guidelines are described as follows.

- General design guidelines still applicable for this alternative.
- Left-side bike lanes should be placed on the right side of physical medium.
- Two parallel dash lines should be provided to indicate the bicycle crossing path from right to left at the beginning of street and from left to right at the end of street.
- Bike lane treatment on the left side of the road should keep consistent with one-way street treatment.

- **Specific signs should be installed. For example, “left lane bike only” signs should be placed along the left bike lane. Also, other “stop” or “yield” signs should also be placed as accommodations.**

Central Lamar St.

This street is a big bus hub for off-campus bus routes to the south side of campus. It is one-way and not restricted. The conflicts between bicycles and buses as we discussed for West Lamar St also exist here. Thus, left-side bike lane treatment is also applicable here. Left-side bike lane will be placed at the left side of street.

Improvements for Bike Signage

As we discussed above, improvement of bike signage is needed on the TAMU campus. The improvement of signage will not only provide way-finding solutions, but also increase the caution of both drivers and cyclists. This should enhance the street safety. Manual on Uniform Traffic Control Devices (MUTCD) (FHWA, 2009b) provided a comprehensive signage design of bike lanes. Based on situation of TAMU campus, signage suggestions are made as follows. For special treatment signs, please refer to bike lane improvement part.

Bike Lane Sign

Purpose of bike lane signage is to inform cyclists they have designated bike lanes and to make automobile drivers aware of cyclists are sharing the road. This type of signs is applicable for roads with bike lanes or paved shoulder. When bike lane markings exist, bike lane signs are still needed. However, to avoid over use of signs, they may not be placed adjacent to each other. (FHWA, 2009b) Designs for bike lane signage include but not limit to the examples that are showed in Figure 23.

Combined use of these sign plaques is highly recommended. Examples are showed in Figure 24.

The bike symbol in R3-17 can make people aware of the existence of bike route from a far distance and R7-9a and R7-9 give out the explanation of bike lane use regulations that will help un-experienced cyclists and drivers to understand the rules. In this way, potential road miss-behavior could be avoided.

"If used, Bike Lane signs and plaques should be used in advance of the upstream end of the bicycle lane, at the downstream end of the bicycle lane, and at periodic intervals along the bicycle lane as determined by engineering judgment based on prevailing speed of bicycle and other traffic, block length, distances from adjacent intersections, and other considerations." (FHWA, 2009b) Minimum sizes for R3-17 is 24 X 18, R7-9a and R7-9 are 12X18.



Figure 23 Examples of bike lane signs recommended by MUTCD (FHWA, 2009b)



Figure 24 Example of combined use of bike signs (FHWA, 2009b)

Begin and End Signs for Bike Lanes

Begin and end signs give cyclists and drivers an alert of the upcoming bike lanes or the possibility of disappearance of bike lane. This is extremely helpful for cyclists that are not familiar with the road condition. Being informed ahead would give both drivers and cyclists some time to decide to stay in this road or not. End of bike lane signs can also prevent cyclists from being panic of suddenly merge with other transportation forms.

Begin and end signs are usually combine bike lane sign with other plaques. At main campus area, there the connectivity is fairly good, especially if proposed bike lane improvement were implemented, this type of signs is rarely needed. Currently, there is only one sign belongs to this type, according to the site survey. It is located at the west end of bike lane on Research Pkwy. In order to keep consistency of campus bike signage, this sign should be replaced by

proposed signage style. For current condition, typical locations that should install these signs are the intersect points of school boundary some campus streets, which include New Main Dr, Bizzell St, and Olsen Blvd. The size for bike lane plaques is 24X18. (FHWA, 2009b)



Figure 25 Example of begin and end signs



Figure 26 Example of bike lane end sign (College Station)

Shared-use Path (optional)

There are some streets on campus that do not have bike lane/paved shoulder but bicycles can still be found there. Possibility of potential conflicts is much higher here than those streets with bike lanes. Adding signage will help to reduce the safety problem. Possible signage includes:



Figure 27 Example of signs for shared-use path

Other signs, such as “stop” sign and “yield” sign should be used supplementary.

CONCLUSIONS

1. In terms of geographic and demographic characteristics, Texas A&M University has a bike-friendly campus.

- a) The size of the campus is neither too large nor too small. Bicycles can provide users a faster and more convenient way to travel.**
- b) TAMU has a diverse population with high ratio of students that are more susceptible to use bicycles.**
- c) The campus is not so hilly that it’s difficult for people to riding bikes.**
- d) Traffic on campus is relatively calm.**

2. Bike ridership has increased significantly during the past three years. More people are willing to use bicycles. However, people are not satisfied with current supply of bike facilities and have concerns about safety issue. Many people indicate that if more bike facilities

were installed, for example, dedicated bike lanes and bike racks, they would be willing to use their bikes more frequently.

3. According to suitability analysis, there are some characteristics that bike-friendly streets have in common. They all have marked bike lanes, have decent street pavement, have low traffic volume, have sufficient bike signage, and have few potential conflicts with other travel modes.

4. We can see that the improvement of bike facilities on campus did encourage more ridership if we look at bike surveys. During 2011 to 2012, many designated bike lanes and bike racks were added by Transportation Service; this is also the time that the ridership has increased significantly.

5. Though many improvements have been completed on campus the bike facilities on campus are still insufficient.

a) Connectivity of the bikeway network is lacking at some areas. It is not difficult to find discontinuity of bike lanes and paved shoulders on campus.

b) Bikeway network does not have a comprehensive plan, which leads to the inconsistency in the bikeway design and connectivity.

c) Bike signage is insufficient on campus as there are not enough bike signs and the style of signs needs to be improved. Lack of signage might cause confusion and misuse of road facilities.

d) Some road pavement needs to be renovated. Bad road pavement discourages potential cyclists to ride their bikes.

e) Although, Transportation Service has been installing new bike racks, in some locations bike parking supply still cannot match the demand. Concerns about difficulties of find available bicycle parking have discouraged people from using their bikes.

6. Improvements and recommendations.

a) More bike lanes need to be added into the bikeway network. Streets that need improvements on bike lanes have been pointed out. General design guideline for conventional bike lanes has been proposed.

b) Special treatments need to be placed at some certain locations. The proposed special treatments are mainly focus on the solution of one-way street traffic flow and the solution of conflicts between bicycles and other transportation forms. Several alternatives were described in details. Proposed innovative bike lane treatments include contra-flow bike lanes and left-side bike lanes.

c) New signage style is suggested to replace the existing bike signs. Also, more signs need to be erected. Types of signage include bike lane signs, begin and end signs, and signs for shared-roads.

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Yichi Liu

BOOK RECEIVED:

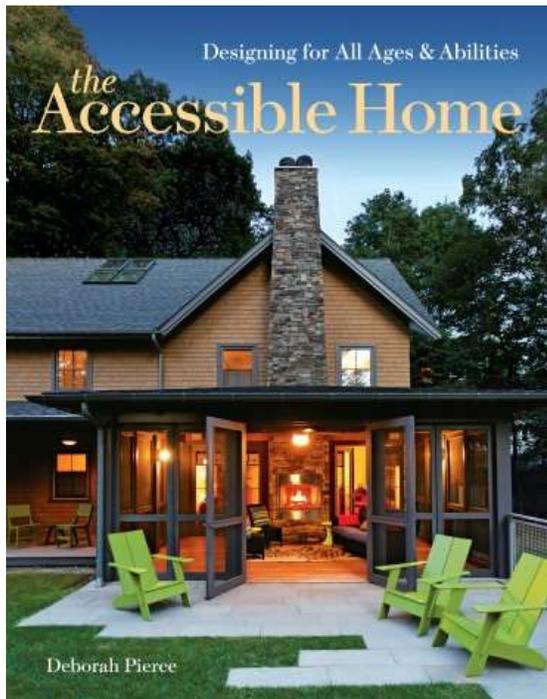
Press Contact:

Linda Stephen, IWPR Group

linda@iwprgroup.com

402-483-0747

The Accessible Home: Designing for All Ages & Abilities ***New Book by Architect Deborah Pierce***



Newton, Connecticut (October 23, 2012) – The Taunton Press is pleased to announce the publication of *The Accessible Home: Designing for all Ages and Abilities*, by Deborah Pierce. Foreword by Michael Graves, FAIA.

This first-of-a-kind home design book addresses the needs of families, couples, and visitors looking for an accessible home that is both beautiful and functional. The Accessible Home shows how ordinary people with extraordinary challenges can partner with architects, designers, and their own families to create homes that restore capabilities, independence and the grace of daily living.

The book is also a tool for the more than 80 million Baby Boomers to age in place in their current homes and lead a lifestyle with

independence, comfort, and safety for decades. A recent survey by AARP revealed that 84 percent of Boomers would like to stay in their current homes during retirement, but only 16 percent have taken any steps to adapt their homes accordingly.

Author Deborah Pierce is one of our nation's foremost experts on universal design. As an architect for the past three decades, she has been focusing on how a home serves the activities of daily living. As a result, the projects in this book convey the power of universal design – useable by everyone.

Michael Graves, FAIA, says, "Deborah Pierce tackles the small problems along with the large in her quest to make wonderful places where people with disabilities can live comfortably and safely."

Homeowners, architects, designers, remodelers and builders will find ideas, inspiration and courage to create homes that are unique to each household's requirements and at the same time, attractive to broad segments of the population. She shows us that "accessible" can be beautiful and functional, light and airy, low-maintenance, safe and comfortable, and that universal design today is a far cry from the grab-bars and ramps of yore.

The Accessible Home features 25 new and remodel projects and 225 photos from across North America to show readers how to create a home that serves its owners for years to come.

Title: *The Accessible Home: Designing for All Ages & Abilities*

Publish date: October 23, 2012

Publisher: The Taunton Press

ISBN-13: 978-1-60085-491-0

Price: \$27.95

Pages: 224

Photos: 225

Drawings: 30

Cover: Paperback

Trim Size: 8 ½ x 10 7/8 inches

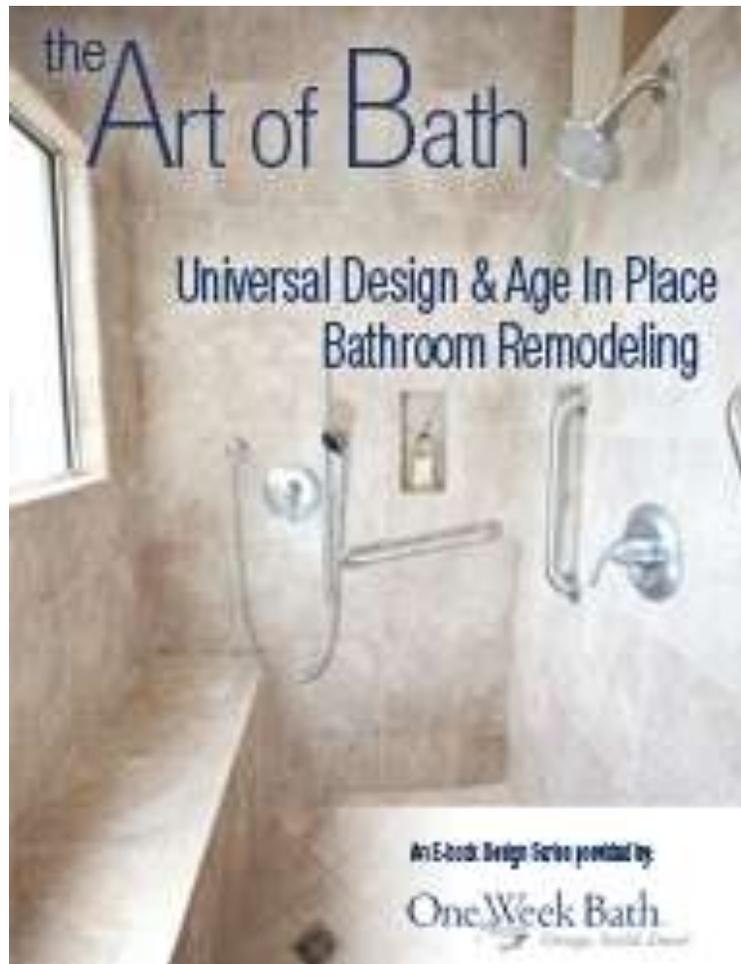
Taunton Product: 071400

Web site: <http://www.taunton.com>

About the author: Deborah Pierce, AIA, is principal of [Pierce Lamb Architects](#) in Newton, Mass. and lectures across the country on the topics of architecture, accessibility and universal design.

2.

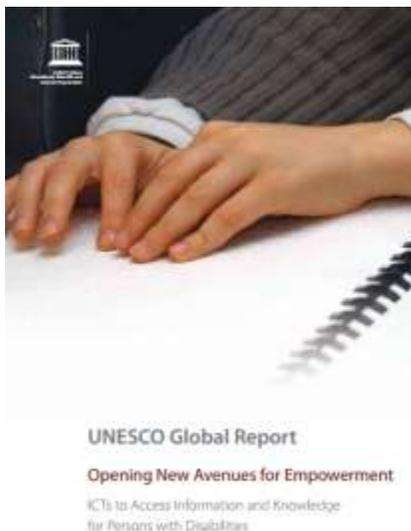
New E-Book on Universal Design Bathroom Remodeling Provides a Blueprint for Artful Style and Accessibility



NEWS:

1.

Building on the United Nations Convention on the Rights of Persons with Disabilities, this Global Report addresses strong recommendations to all stakeholders – from decision-makers to educators, civil society and industry – on how concretely to advance the rights of people with disabilities. These recommendations draw on extensive research and consultations. Studies launched in five regions have allowed UNESCO to understand more clearly the conditions and challenges faced by persons with disabilities around the world.



To empower persons with disabilities is to empower societies as a whole – but this calls for the right policies and legislation to make information and knowledge more accessible through information and communication technologies.

It calls also for applying accessibility standards to the development of content, product and services. The successful application of such technologies can make classrooms more inclusive, physical environments more accessible, teaching and learning content and techniques more in tune with learners' needs.

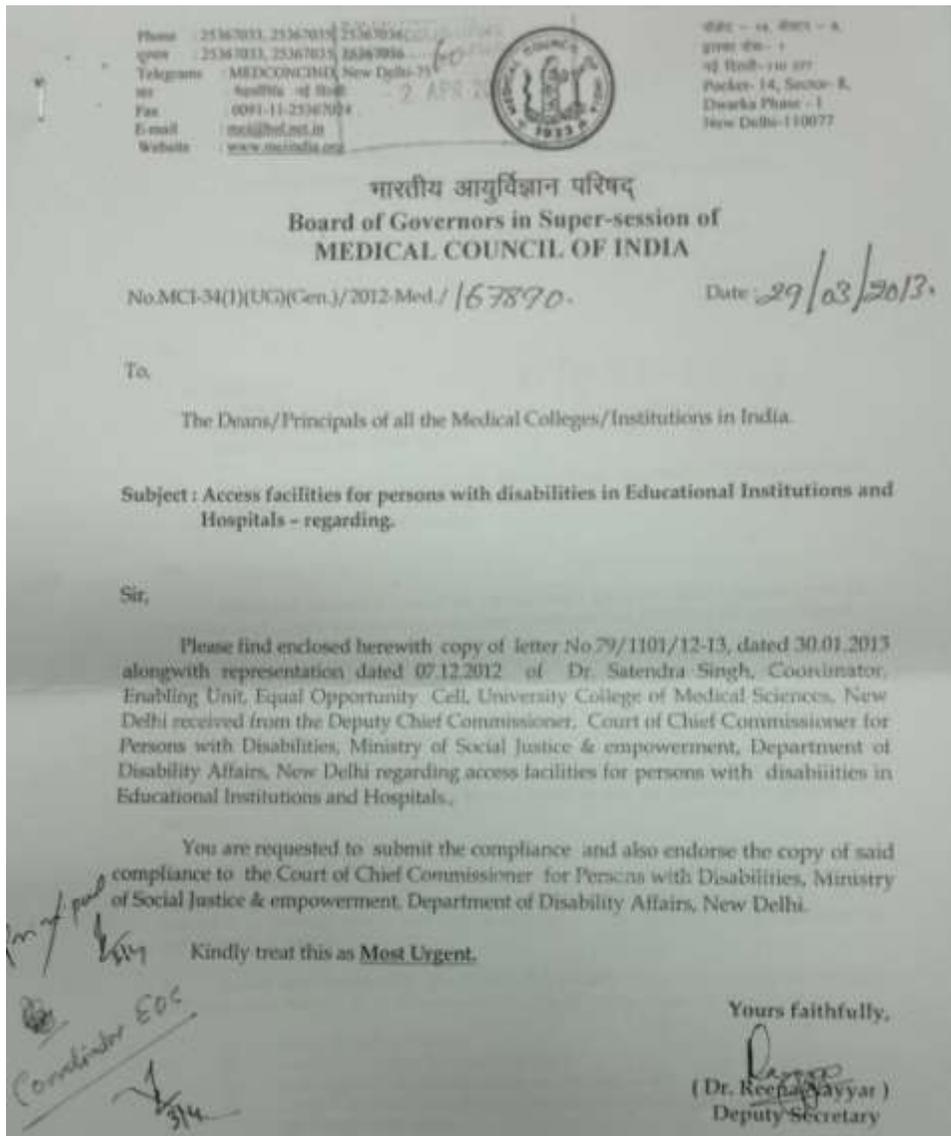
This UNESCO publication not only makes a major contribution to the understanding of disability, but also highlights technological

advancement and shares good practices that have already changed the lives of people with disabilities. It also makes concrete recommendations for action at the local, national and international levels, targeting policy and decision makers, educators, IT&T industry, civil society and certainly persons with disabilities.

Download the [UNESCO Global Report](#).

(Curtsey: UNESCO)

2.



Dear Sir,

Based on my representation and notice issued by Chief Commissioner for persons with disabilities (CCPD), MCI has issued directive to the Deans/Principals of all the Medical Colleges/Institutions in India to submit compliance report on access facilities for persons with disabilities.

Warm regards

Dr Satendra Singh MD, CMCL FAIMER fellow, FSS Assistant Professor of Physiology, Member, Medical Education Unit Member, Medical Humanities Group, Founder, Infinite Ability Coordinator, Enabling Unit, EOC, Creator, The Enablist University College of Medical Sciences & GTB Hospital, Delhi, India-110095

3.

CapitaLand accorded the largest number of Universal Design Mark awards

CapitaLand bags eight Universal Design Mark awards; conferred Quality Champion (Gold) for the inaugural BCA Quality Excellence Award

Singapore, 16 May 2013– CapitaLand Limited (CapitaLand) has been accorded the largest number of Universal Design Mark awards at the annual Building and Construction Authority Singapore Awards 2013 (BCA Awards). Eight CapitaLand properties including homes, office buildings and shopping malls were conferred the Universal Design Mark, a voluntary initiative launched in October 2012 to encourage the adoption of a user-centric philosophy in building design, operations and maintenance. In support of the new initiative, CapitaLand has set a minimum requirement of Universal Design Mark Gold for its new projects in Singapore.

CapitaLand has also been conferred the Quality Champion (Gold) for the inaugural BCA Quality Excellence Award, testament to CapitaLand's track record in delivering high quality homes. CapitaLand has close to 10,000 units in 30 residential projects that have been certified or committed under the Quality Mark scheme since it was introduced in 2002.

Since last year's BCA Awards, CapitaLand has added 11 awards to its Green Mark stable, including Green Mark Platinum for Westgate and Capital Tower, bringing the total to 75 Green Mark awards (including 12 provisional awards) for its development projects in Singapore, China, Indonesia, Malaysia and Vietnam.

Westgate is an integrated development comprising a seven-storey shopping mall (also named Westgate), and a 20-storey office tower, called Westgate Tower. It has been conferred both the BCA Green Mark Platinum, the highest green building accolade, and Universal Design Mark GoldPlus for its building design. Bedok Mall and Bedok Residences, and CapitaGreen which received the Green Mark Platinum in 2012, as well as JCube, which received its Green Mark Platinum in 2011, have also been conferred the Universal Design Mark GoldPlus. Capital Tower, one of the first office buildings in Singapore to be certified Green Mark Gold upon the launch of the BCA Green Mark in 2005, has been re-certified and awarded the highest Green Mark Platinum rating this year.

Mr Lim Ming Yan, President & Group CEO, CapitaLand Limited, said: "CapitaLand is committed to operational efficiency as well as sustainable development and management. Our stakeholders interact with our homes, office buildings, shopping malls, serviced residences and mixed developments daily. Therefore, it is important for us to have a user-centric approach when we design, build and operate our properties. Building quality developments that are accessible and environmentally sustainable should be a common goal for the real estate industry."

Mr Tan Seng Chai, Group Chief Corporate Officer, CapitaLand Limited, said: "As a socially responsible real estate developer, CapitaLand's commitment to sustainability has driven us to set high standards in terms of universal design, environmental sustainability, quality and construction excellence. We have set the minimum requirement of Universal Design Mark Gold for our new projects in Singapore. New buildings and existing buildings undergoing major renovation in Singapore also have to achieve a minimum Green Mark GoldPlus rating."

CapitaLand implements its Green Building Guidelines to ensure that environmental, universal design, safety and health considerations are factored in at all stages of its projects, from feasibility, design, procurement, construction to operation. The guidelines are regularly reviewed to ensure continuous improvement.

Recently, CapitaLand was ranked eighth in the Environmental Tracking Asia-Pacific 300 Carbon Ranking by the Environmental Investment Organisation (EIO) an independent not-for-profit research body promoting carbon transparency and investment solutions designed to address climate change. In recognition of this, CapitaLand was conferred the 2013 Environmental Tracking Carbon Ranking Leader Award, the only Singapore real estate developer to have achieved top 10 in the carbon ranking in Asia Pacific.

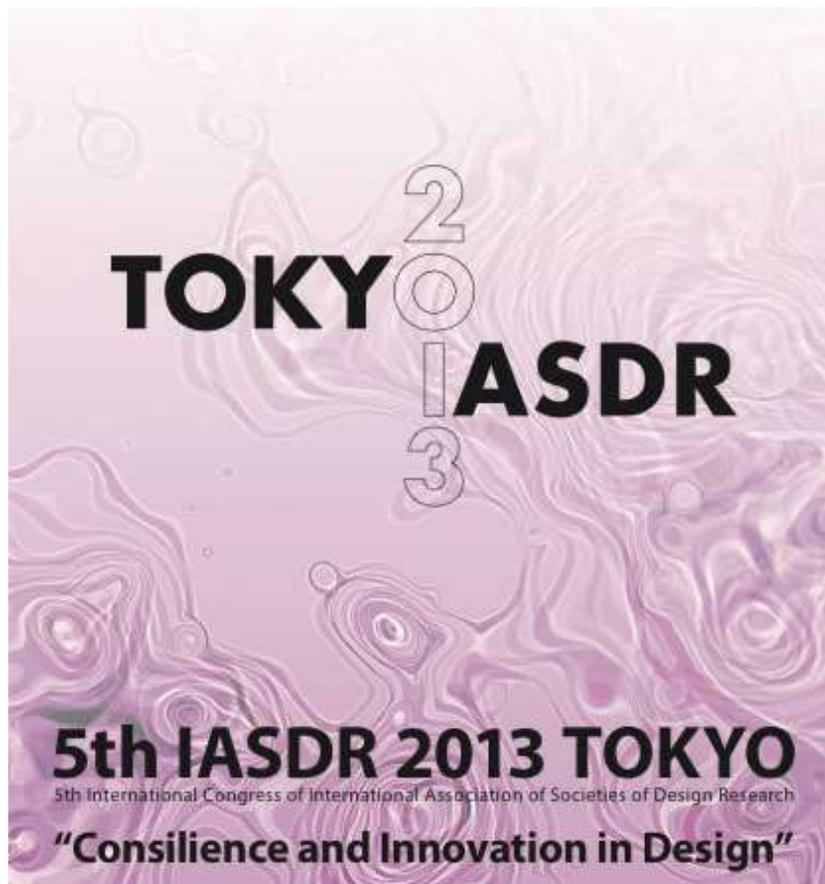
Mr Sam Gill, CEO of Environmental Investment Organisation, said: "Whilst effective greenhouse gas emissions reporting is certainly not an easy task for any company, it is excellent that certain companies have demonstrated that it can be done and to an ever increasingly higher standard. Since 62% of companies in the ET Global 800 reported incomplete data or no data at all, any company ranking within the top 10 in their respective region should be viewed as a pioneering leader, constantly raising the bar for others around them."

Please refer to the Annex for a listing of CapitaLand's 2013 BCA Award winners and more details on the respective award-winning projects.

(Courtesy: CapitaLand Limited)

Program & Events:

1.



2.



3.



HCI International 2013

21 - 26 July 2013, Mirage Hotel, Las Vegas, Nevada, USA

4.

1st Call for Papers: WG 9.4: Social Implications of Computers in Developing Countries

12th International Conference on Social Implications of Computers in Developing Countries

Conference Theme: Into the Future: Themes, insights and agendas for ICT4D research and practice

Ocho Rios Jamaica, 19-22 May, 2013

Submission Deadline: 26 November 2012



5



Universal Design Summit 2013
St Louis, MO

As an industry leader *we cordially invite you to attend our*
5th Universal Design Summit (UDS5).

This event is focused exclusively on housing and communities that meet the interests of your 21st century customers.

- Learn about **Better Living Design**, the new national initiative that will change the landscape of UD practice and consumer demands.
- Meet 500 industry leaders from around the country who are including accessible and Universal Design in new and remodeled homes.
- Get the latest information about accessible and universal products and designs.

udsummit.net



6.



products, news, business
2013 IDEA open for entries

28 November 2012 by Kate Jones
The 2013 International Design Excellence Awards is open for entries.

[home](#) / [2012](#) / [november](#) / [2013 IDEA open for entries](#)

The Industrial Designers Society of America (IDSA) are calling for entries for their annual International Design Excellence Awards® (IDEA) competition for 2013.

7.



International Istanbul Initiative on Ageing 4-6 October 2013

The International Federation on Ageing and Turyak Seniors Council Association cordially invites you to **submit abstracts for oral presentations** at the International Istanbul Initiative on Ageing. All abstracts will be reviewed by the Program Committee and assigned to the appropriate concurrent session for oral presentations. Abstracts from around the world are welcomed to share best practices to the regions of the Middle East, Northern Africa, Eastern Europe, and surrounding countries of Turkey. Abstracts must relate to one of the 13 sub-themes identified.

Abstract submissions are entirely separate from full paper submissions, and will therefore *not* be eligible for financial prizes or publications. For more information about Full Papers visit www.ifa-fiv.org.

Deadline: May 31, 2013 at 5pm EST

8.



9.



10.



11.



Fifth Universal Design Summit 2013 (UDS5)

For four previous conferences The R.L. Mace Universal Design Institute (UDI) staff has collaborated with The Starkloff Disability Institute (SDI) to provide a unique educational experience showcasing good examples of universal design that can be incorporated into housing and neighborhoods.

As North America's only conference focused on housing and communities usable by all, UDS5 continues a tradition of providing exceptional content on universal design in housing, sustainable design, community design, and affordability. UDS5 will offer learning opportunities through informal discussion, breakout, and plenary sessions. The conference will feature exhibits, design charrettes, workshops, and a tour of universally designed housing and neighborhoods.

[Continuing Education Credits](#) are available. See [what people are saying](#) about UDS4 and UDS5.

Universal Design Summit 5, May 6-8, 2013

Saint Louis University

Busch Conference / Student Center
20 North Grand Boulevard
St. Louis, Missouri 63103

12.



13.

The National Council on Independent Living (NCIL) will hold its annual conference on July 24 – 27, 2013 in Washington, DC.



14.

TIEMS Berlin Conference 2013



on

Public Alerting and Social Media during Crisis and Disasters
30th October - 1st November 2013

TIEMS Berlin Conference Links and Details

[*Invitation and Call for Papers, Posters and Exhibitors*](#)

[*Venue, Hotels and Conference Fees*](#)

[*Submissions and Exhibitors by 1st May 2013*](#)
(Authors from 14 countries have submitted)

Deadline for submission of a paper or poster abstract is *30th May 2013*.

Submission at: [*Berlin Easy Chair*](#)

15.


Department of Civil Engineering, Design,
Construction Industry and Environment (DicDEA)
SECOND UNIVERSITY of NAPLES

In collaboration with

AIAP
Italian association
of visual communication design

International PHD
Design and Innovation

Studio Cioffi & Associati

**DIALOGUES
ON SUSTAINABILITY**
CYCLE OF THE RESOURCES AND VISIONS OF CONTEMPORARY DESIGN
DIALOGUE ON WATER RESOURCES

09_May 2013
h 09.30_18.00

Department of Civil Engineering,
Design, Construction Industry and Environment
(DicDEA)

*Real Casa dell'Annunziata
Via Roma 29 | Aversa (CE)*

16.

Hong Kong Young Design Talent Award 2013 - Call for Application HK\$500,000 Award grant for supporting elites to undergo overseas work attachment

Organised by Hong Kong Design Centre (HKDC), "Hong Kong Young Design Talent Award" (HKYDTA) has started calling for application on 1 May. HKYDTA aims to support young design practitioners and design graduates to undergo overseas work attachment in renowned design companies for half to one year and contribute to Hong Kong's design and creative industries afterward. HKYDTA awardees may receive a grant of HK\$500,000 including sponsorship of daily expenses and valuable chances of overseas work attachment in renowned design companies such as Muji(Japan), Ecco Design(United States) and 3XN(Denmark).

HKYDTA aims to cultivate up-and-coming design talents with sponsorship granted for them to undergo overseas work attachment. They will contribute to the development of Hong Kong's design and creative industries by returning to Hong Kong immediately upon completion of overseas work attachment and working for not less than 2 consecutive years for a Hong Kong business. Also, they will become the ambassadors of HKYDTA and share their overseas experience with the organisers or sponsors. Organised since 2005, more than 400 applications were received. More than 40 awardees were given grants to continue their professional pursuits overseas.

There are 4 grand awards in HKYDTA 2013: "CreateSmart Young Design Talent Award" will sponsor 2 design practitioners in maximum with a grant of HK\$500,000 each. "CreateSmart Young Design Talent Special Award" will sponsor 2 design practitioners or design graduates in maximum with a grant of HK\$250,000 each. "PolyU School of Design Young Design Talent Award" will sponsor a design graduate with a grant of HK\$250,000. "HKDI Young Design Talent Award" will sponsor a design graduate with a grant of HK\$250,000. Besides, HKYDT Special Mention Award is introduced to reward excellent applicants.

Candidates will be assessed by a panel of expert judges based on several criteria such as their possible future contributions to the development of design and innovation in Hong Kong, effectiveness of communication, quality of portfolio and plans for using the Award's grant. The deadline for online application of HKYDTA will be 31st July 2013 and deadline for submission of supporting document by post will be 15th August 2013. For more information of HKYDTA, please visit www.ydta.hk.

Overview of awardees' designated overseas design companies

Category	Company Name	Country
Apparel and Accessory Design	HENRIK VIBSKOV STUDIO	Denmark
Communication Design	Base Design	Belgium
Communication Design	Studio Dumbar	Belgium
Environmental Design	JDS Architects	Belgium
Environmental Design	Grant Associates	United Kingdom
Environmental Design	3XN	Denmark
Multi-disciplinary	ROSAN BOSCH	Denmark
Multi-disciplinary	ISKOS-BERLIN Design	Denmark
Multi-disciplinary	Fabrique	The Netherlands
Product and Industrial Design	Phoenix Design GmbH + Co KG	Germany
Product and Industrial Design	Nosigner	Japan
Product and Industrial Design	MUJI / Ryohin Keikaku Co Ltd	Japan
Product and Industrial Design	Takram Design	Japan
Product and Industrial Design	Tamawa Design Studio	Belgium
Product and Industrial Design	ECCO Design Inc	United States

* More design companies may be added to the list, please periodically visit <http://www.ydta.hk/2013/pages/en/categories/worldwide.php> to review the latest information.

Showcase of 2012 Awardees' works

“CreateSmart Young Design Talent Award”: Au Yeung Wai-hon, Hamlet, Kwok Yum-tsung, Calvin



Work from Au Yeung Wai-hon, Hamlet



Work from Kwok Yum-tsung, Calvin

“CreateSmart Young Design Talent Special Award”: Chan Wing-kei, Quai, Lau Wein-sie, Fiona

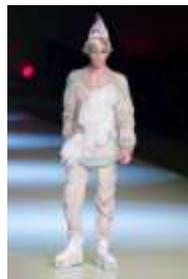


Work from Chan Wing-kei, Quai



Work from Lau Wein-sie, Fiona

“PolyU School of Design Young Design Talent Educational Award” (renamed as “PolyU School of Design Young Design Talent Award” this year): Chow Ka-wa, Key



Work From Chow Ka-wa, Key

“HKDI Young Design Talent Educational Award” (renamed as “HKDI Young Design Talent Award” this year): Lam Wai-keung, Sonic



Work From Lam Wai-keung, Sonic

About Hong Kong Young Design Talent Award (HKYDTA):

Hong Kong Young Design Talent Award (HKYDTA), organised by the Hong Kong Design Centre (HKDC), aims to support and cultivate up-and-coming designers with sponsorships granted for them to undergo overseas work attachment in renowned design companies to unleash their potential.

The awardees are entitled to undergo overseas work attachment for at least 6 to 9 months, which allows them to elevate their versatility and professional knowledge.

All awardees will contribute to the development of Hong Kong's design and creative industries by returning to Hong Kong after completion of their overseas work attachment. They will become ambassadors of HKYDTA to share their overseas experience.

About Hong Kong Design Centre:

Design for Society is the major undertaking of Hong Kong Design Centre (HKDC). HKDC is a non-profit organisation and a strategic partner of the HKSAR Government in developing Hong Kong as an international design hub in Asia. Since 2002, HKDC has been on a public mission to (i) champion strategic and wider use of design for creating business value and community benefits; (ii) promote and celebrate design excellence; and (iii) educate the professions and the community to be resourceful champions for sustained developments through design and innovation.

This press release was distributed by **DT Communications Asia Pacific** on behalf of **Hong Kong Design Centre**. For any enquiries, please contact:

DT Communications Asia Pacific

Karen Ng

Tel: +852 3696 6944

E-mail: karen.ng@dt-asia.com

17.



Job Openings:

1.

Sr. Faculty

Qualification Experience

1.

Fashion Management & Marketing – 1 Post

Post Graduate in Fashion Management or equivalent course from a recognized Institute

Minimum 6-10 years experience in Marketing department of Fashion Industry / Fashion House/ Design Institute

2.

Fashion Design & Illustration – 1 Post

Post Graduate in Fashion Apparel Design from a recognized Institute Minimum 2 years experience in design department of Fashion Industry / Fashion House/ Design Institute

3.

Fashion Design & Illustration – 1 Post

Post Graduate in Fashion Apparel Design from a recognized Institute Minimum 10 years experience in design department of Fashion Industry / Fashion House/ Design Institute

4.

Store & Display Design – 1 Post

Graduate or Post Graduate in any specialization of Design Minimum 6 years experience in "Visual Merchandising & Store / Exhibition design".

5.

Textile Design studies for Fashion Design – 1 Post

Graduate or Post Graduate in any specialization of Textile Technology Minimum 6 years experience in "Textile studies for Fashion Design".

6.

Fashion Imaging

Graduate or Post Graduate in any specialization of Fashion Communication / FPI from a recognized Institute Minimum 6 years experience in Communication department of Fashion /advertising Industry.

Please send your resumes to the following Address or e-mail to:

**MAEER's MIT Institute of Design ,Rajbaug, Loni-Kalbhor, Pune-412201 Ph. no.:
020-30693607 Fax: 020-30693601 E-mail: hr@mitid.edu.in
mailto:hr@mitid.edu.in Web site: www.mitid.edu.in**

2.

Opportunity with a Product based MNC for UX Lead/Architect

Exp: 8 to 14 Yrs

Location: Bangalore

Skills: UX/UI, CSS, HTML

Core Design Concept

- **User Interface Conceptualization, Creative thoughts to give value for Business.**
- **User Interface Design, User Centered Design, Usability Testing, Wire frames creation.**
- **Create mock-ups and prototypes of visual designs to communicate UI strategy**
- **Knowledge of latest web design trends and user experience needs.**
- **Good Knowledge and understanding of HCI (Human Computer Interface).**
- **Good knowledge of web like CSS, HTML etc..**

Technology

- **Photoshop, CS2, CS3, and CS4, Dream Weaver, Knowledge of Flash and Flex will be advantageous.**
- **Hands on Experience in mock-up and prototype for UI integration support.**
- **Knowledge of latest MS Office tools, version control (VSS, SVN etc.)**

● **Desired Candidate Profile:**

- **Being pro-active in delivering innovative and cost effective solutions to Business**

Objectives

- **Ability to take challenges and more responsibilities.**
- **Good knowledge of HTML5, CSS3, JavaScript**

Please send updated CVs along with your portfolio/ links to portfolio to padma@hireatease.com , for more info call +91- 855 350 3448

3.

Lord Cultural Resources is a global professional practice dedicated to creating cultural capital worldwide. Our projects include museums, mixed-use developments, cultural centres, art galleries, science centres, world expositions, visitor centres, heritage sites, festivals, theatres, archives, libraries and gardens. Our clients are in all sectors including private and public corporations, foundations, governments and non-profit institutions.

You can find out more about us on our website: <http://www.lord.ca/><<http://www.lord.ca/>>

The India office of Lord Cultural Resources is looking for a Senior Exhibition Designer to join their team in Mumbai. The person should have a minimum of 8-10 years of experience working on the design, detailing and execution of museum exhibits.

Those interested, please write to lcr.mumbai@gmail.com with your resume

4.

Tata Elxsi is in search of creative, energetic and talented industrial designers to join our Pune Studio. You will have the opportunity to work on a wide variety of design project of different kinds.

We are looking for a candidate with a minimum of 2 years of professional experience, who is passionate about design and understands the challenges of manufacturing. Candidate needs to have relevant experience in either of the mentioned domains, Consumer Electronics, Medical Device, Appliances or Packaging. Please send in your resume and portfolio to sandeepthombre@tataelxsi.co.in

5.

VJ Media Works is a media company with interest in publishing and industry events related to the marketing communication and retail businesses. The company already owns three established publishing brands like Point-of-Purchase,

Outdoor Asia and VM&RD - Visual Merchandising & Retail Design targeted at the In-Store marketing fraternity, OOH advertising community and retailer, design community & VM industry in the country respectively.

The magazine concepts also extended to on-ground events in the form of In-Store Asia, Outdoor Advertising Convention and Talks OOH

We are looking for

1. Sr. Graphic Designer - with 5-6 Years experience, who can visualize, do ideation and guide the team.

2. Graphic Designer - with 1-2 Years experience who will able to execute the design as per the requirement.

The team will be required to do the campaign for our internal products and events as well campaign for our costumer.

pl get in touch directly with Mr Vasant Jante at vasant@vjmediaworks.com



Advertising:

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advertisement@designforall.in

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Forthcoming Events and Programs:
Editor@designforall.in

The views expressed in the signed articles do not necessarily reflect the official views of the Design for All Institute of India.

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