



The Sustainable City and Biking: Implications for Health, Environment, and Economy

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Introduction

"I think [the bicycle] has done more to emancipate women than anything else in the world," said feminist pioneer Susan B. Anthony in 1896. The bicycle now has the potential to emancipate not just women—but everyone. The University of Louisville (U of L) has a great opportunity to lead by example in the city of Louisville and adopt a cycling infrastructure on campus. This would allow the city as a whole to witness the positive impact of biking on personal health, environmental protection, community development, economic growth and neighborhood stabilization.

A bicycle-friendly environment may sound logical and even simple today, but the challenges of establishing a cycling infrastructure are numerous and can be found multiple times throughout history. Although bicycles were first invented in the early 1800, for a long time they were considered a novelty.

In 1880, the League of American Wheelmen was formed to promote bicyclists' interests. Over the next decade, local clubs of cyclists or "wheelmen" formed throughout the country. By 1898, according to the League of American Bicyclists' web site, the League had more than 102,000 members, including the Wright Brothers, Diamond Jim Brady and John D. Rockefeller. Many clubs had meeting halls and admitted women as well as men. Since that time, the bicycle has largely been limited to recreation instead of transportation, inhibiting the creation of cycling infrastructure we desperately need in today's society.

Our study shows that individuals will utilize biking as more than a means for recreation when the proper infrastructure is built. Increasing bicycle ridership promotes calmer and less congested streets and crime reduction because of more activity on the street. Residents of neighborhoods that encourage biking by providing bike lanes and other cycling infrastructure could potentially save up to \$8,000 per year by ditching their cars and commuting by bike. Not only will they have more money in their pockets, they will improve their health by increasing exercise. Furthermore, those who utilize alternative transportation will use their savings to improve their quality of life and support the community by improving their housing and purchasing goods and services locally. This fosters a greater sense of community and increased property values.

Using U of L as an example, our study shows that by choosing to bike, an individual could save up to \$32,000 over a four-year period by avoiding the purchase of a car as well as the cost of maintenance, insurance, fuel, and parking permits. By providing a dedicated bicycle lane for students, staff, and faculty who live in close proximity to the university and have a willingness to commute by bicycle, a \$68 million savings could be generated within the community. These savings would greatly benefit the local economy by creating opportunities to reinvest money in homes and to support local businesses.

The goal of this project is to encourage the adoption of a comprehensive bicycle plan for U of L that will serve as a demonstration project for both the Louisville Metro Government and other similar metro areas across the country.

The importance of this project will be emphasized with support from a thorough literature review of the benefits of bicycling and through the analysis of survey data from the U of L community. This work was completed under the direction of Dr. John Gilderbloom's Urban and Public Affairs Advanced Topics/Urban Research Seminar bikeability course which included graduate students from the School of Public Health and Information Sciences, Urban Planning, and Public Administration.



Figure 1. Albert Einstein

U of L Survey and Data Analysis

In the spring of 2010, at the request of the Sustainability Council and Sustainable Urban Neighborhoods Program, a survey was conducted on a sample of students, faculty and staff at U of L to try to better understand the commuting behaviors of the university community and its perceptions of alternative forms of transportation. The survey was prepared under the leadership of Dr. Gilderbloom and was a collaborative effort between the Center for Sustainable Urban Neighborhoods (SUN), the Special Assistant to the Provost for Sustainability, the Office of Academic Planning and Accountability, graduate students in the Advanced Topics - Bikeability course, the Kentuckiana Regional Planning & Development Agency (KIPDA), and Louisville Metro Government.

The invitation to take the survey was sent to nearly 10,000 U of L faculty, staff and students. Over 1,500 faculty and staff responded, representing almost one quarter of the total faculty/staff at the university. Over 520 students responded. The survey consisted of 32 questions covering commuting behaviors and preferences. Survey controls included housing location, gender, race or ethnicity, occupation at the University, educational attainment, and grade point average. The range of questions included how respondents commute to and from campus, their willingness to pay more for gasoline and parking permits, views on bicycling as a means of transportation, and opinions on the safety of cycling and other forms of transportation. Responses have been examined against the various controls using multivariate regression analyses.

Cycling and Its Benefits

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Non-motorized travel in the Netherlands is about 6 times higher than in the US (Pucher & Dijkstra, 2003).

Figure 2. Men Cycling in Louisville



Figure 3. Max Gilderbloom in the Netherlands



Figure 4. Man and Woman Riding What a Bicycles Used to Look Like



Sources: Courtesy John Gilderbloom

A Public Health Crisis

Public health is influenced by the interactions between people and the built environment through exposures to environmental factors that may reduce/increase risk of injury or even death and can also influence the frequency and type of a person's physical activity. The Tompkins County Planners of New York define the built environment as “the part of the environment formed and shaped by humans, including buildings, structures, landscaping, roads, signs, trails, and utilities” (Tompkins County Planning, 2010). Design elements of the built environment can provide opportunities to improve public health through increased physical activity. Improving the quality of the travel experience of bicyclists through an improved sense of safety, comfort, and accessibility will encourage more physical activity and therefore improve the overall health of Metro residents.

Physical activity decreases morbidity, mortality, and the risk of: cardiovascular disease, certain cancers, diabetes, obesity, and asthma (Wendell, Tom, & Rohm, 1998). In 2005, life expectancy in Kentucky was 75.5 years as opposed to 78.4 years for the US, ranking 43rd in the nation (Health Status – Kentucky, 2010). Jefferson County fares no better with a life expectancy of 75.3 years (Community Health Status Indicators, 2010). During the same time period, life expectancy was 78.8 years in the Netherlands (Netherlands Life expectancy at Birth, 2010), a nation known to be more bike and pedestrian friendly (Gilderbloom et al., 2009). Non-motorized travel accounts for 40 percent of all trips in the Netherlands, nearly six times greater than the US rate of 7 percent (Pucher & Dijkstra, 2003).

In 2006, Kentucky was ranked sixth highest in the nation for heart disease mortality with a rate of approximately 1 out of 425 people, compared to the national heart disease mortality rate of approximately 1 out of 500 people (Health Status – Kentucky, 2010). Heart disease mortality for Jefferson County is estimated to be approximately 1 out of 483 people (Kentucky Health Facts, 2010). Cancer incidence in Kentucky was the fourth highest in the nation in 2004 (Health Status – Kentucky, 2010). Prevalence of diabetes in Kentucky was 9.8 percent in 2008, 9th highest in the US (Health Status – Kentucky, 2010). Prevalence of diabetes is even higher for Jefferson County at 10 percent (Kentucky Health Facts, 2010). The Netherlands, a more bike- and pedestrian-friendly country had less than half the diabetes prevalence as Kentucky with only 3.9 percent (StatLine, 2008). In 2007, Kentucky ranked sixth highest in the U.S. for adult obesity, as measured by body mass index of 30 or greater (Health Status – Kentucky, 2010). Obesity prevalence in Kentucky is just above the national rate, with values of 66.6 percent and 63 percent, respectively (Health Status – Kentucky, 2010). For childhood obesity, Kentucky ranked third highest in the U.S. with a statewide prevalence of 37 percent, compared to a national prevalence of 32 percent (Health Status – Kentucky, 2010). In comparison with 2005 obesity rates in the Netherlands, US obesity was slightly over 20 percent higher (Gilderbloom et al., 2009). In 2007, Kentucky had the 14th highest asthma prevalence at 9 percent, compared to 8.2 percent for the nation (Health Status – Kentucky, 2010). In Louisville, the asthma prevalence is

even higher at 11 percent (Kentucky Health Facts, 2010) (see Table 1. Health Indicators Associated with Physical Inactivity).

Table 1. Health Indicators Associated with Physical Inactivity

Health Indicator	Jefferson Co.	KY	US	KY Rank*
Moderate/ Vigorous Physical Activity Participation	N/A	42.2% ⁴	49.2% ⁴	464
Life Expectancy (years)	75.31	75.54	784	434
Heart Disease Mortality Rate (per 100,000 people)	206.92	235.54	200.24	64
Cancer Incidence Rate (per 100,000 people)	577.633	500.24	458.24	44
Diabetes Prevalence	10% ²	9.8% ⁴	8.2% ⁴	94
Adult Obesity Prevalence	N/A	66.6% ⁴	63.0% ⁴	64
Child Obesity Prevalence	N/A	37.0% ⁴	32.0% ⁴	34
Asthma Prevalence	11% ²	9.0% ⁴	8.2% ⁴	144

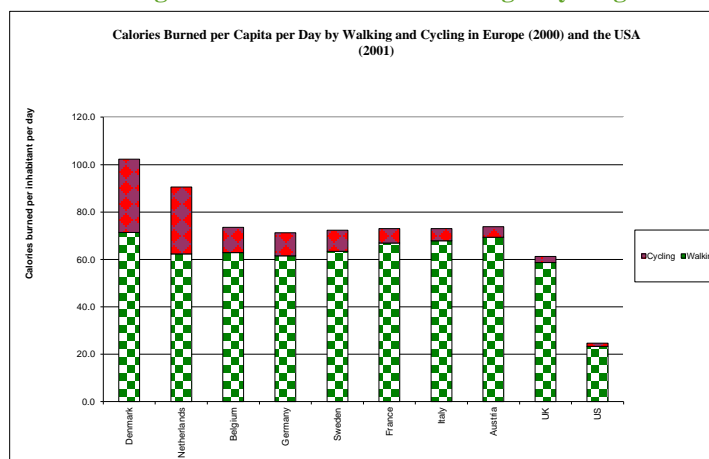
Note: 1. *KY rank in the US. Source: <http://www.statehealthfacts.org/profilecat.jsp?rgn=19&cat=2>. Sources: 1. <http://www.communityhealth.hhs.gov/SummaryMeasuresOfHealth.aspx?GeogCD=21111&PeerStrat=3&state=Kentucky&county=Jefferson>; 2. <http://www.kentuckyhealthfacts.org/data/location/show.aspx?county=Jefferson>; 3. <http://cancer-rates.info/ky/index.php>; 4. <http://www.statehealthfacts.org/profilecat.jsp?rgn=19&cat=2>

In 2010, Louisville was ranked 46th worst of the 50 largest US cities for health indicators influenced by physical activity in the American College of Sports Medicine's annual fitness index ranking. While the city was credited for its per capita park acreage, farmers' markets, golf courses, and tennis courts, challenges include state physical education requirements and the small percentage of the population bicycling or walking to work (ACSM, 2010).

Benefits of Increased Physical Activity

NutriStrategy, a nutrition and fitness organization, estimates that light cycling (10-11.9 miles per hour) could burn between 300-500 calories per hour, 500-700 calories per hour for moderate cycling (12-13.9 miles per hour), and vigorous cycling (14-15.9 miles per hour) could burn between 600 and 800 calories per hour (see Figure 5. Calories Burned During Bicycling). Marshall et al. 2009 reports that “reducing the average energy imbalance (caloric intake minus metabolic activity) among persons in the United States by approximately 100–165 kcal/day would prevent average weight gain” of about 2.2 lbs/year (Marshall et al., 2009).

Figure 5. Calories Burned During Bicycling



Source: <http://www.nutristrategy.com/fitness/cycling.htm>

In addition to reducing risk of chronic diseases and weight gain, regular physical activity also decreases stress levels (Fox, 1999). It is estimated that 47 percent of adults suffer from adverse effects of stress (APA Stress Survey: Children More Stressed than Parents Realize, 2009) and 75 to 90 percent of primary care physician visits are related to stress (America's No.1 Health Problem, 2010). Sixty percent of work absences are attributed to stress, which is estimated to cost companies over 57 billion dollars yearly (Clark, 2010). Stress contributes to mortality from heart disease, cancer, lung disease, accidents, depression, cirrhosis, and suicide. The many physical and mental health symptoms associated with stress provide a stronger argument for increasing access to physical activity because of its stress reducing qualities.

Benefits to the Environment

Increased rates of greenhouse gas (GHG) emissions are warming the earth and carbon dioxide (CO₂) is the primary culprit. In the US, CO₂ accounts for over 80 percent of total GHG emissions (NHTS, 2009). Activities such as burning fossil fuels have increased atmospheric CO₂ levels 35 percent higher than levels present during the industrial revolution. While some in colder climates might lightheartedly welcome 'balmier' weather, the reality is that the effects of climate change could pose serious threats to public health, economic stability and even national security.

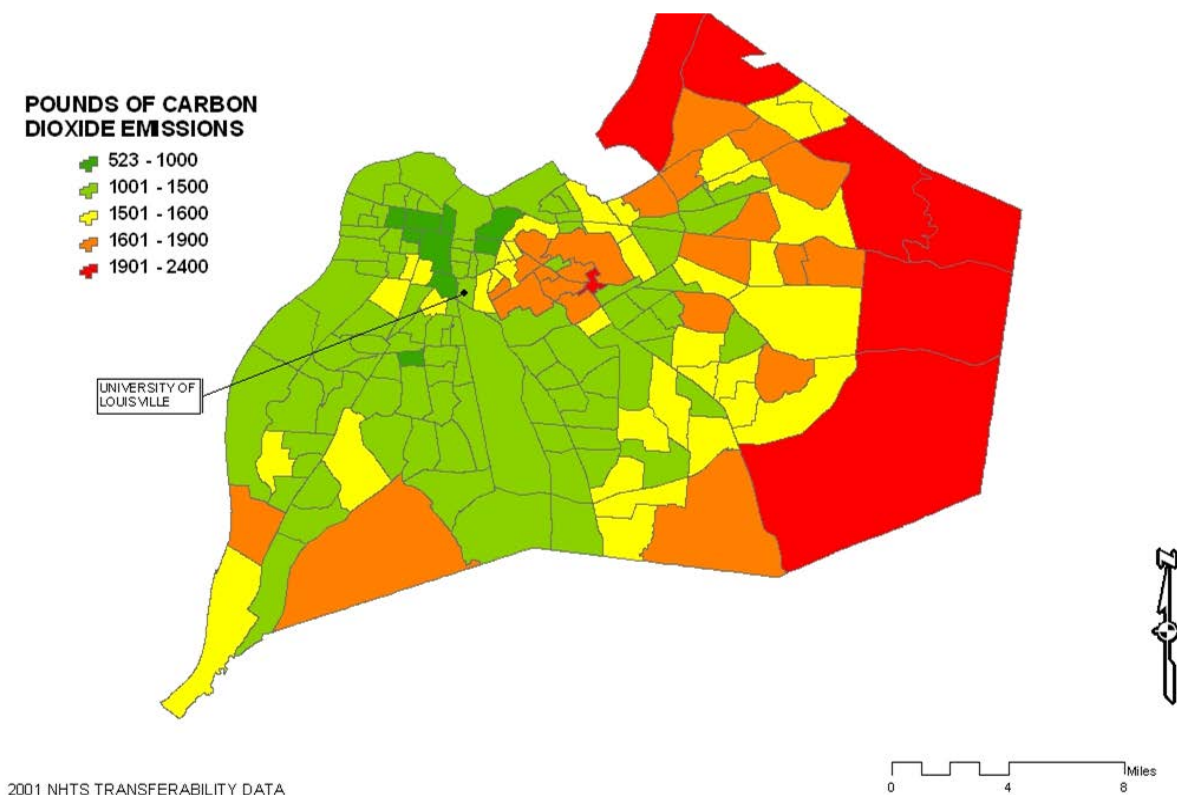
In 2004, transportation accounted for almost one-quarter of the global energy-related CO₂ emissions; motor vehicles accounted for approximately three-quarters of those emissions (Kahn et al. 2007). Approximately one-third of CO₂ emissions in the U.S. are transportation-related and automobile travel accounts for 90 percent of all trips (NHTS 2009, Kahn et al., 2007). Private cars and trucks burn 40 percent of the oil consumed in the U.S.; equivalent to 10 percent of the world demand (Gotschi and Mills, 2008). The U.S. has been binge-drinking oil and the massive hangover is just setting in. The combustion of each gallon of gasoline for transportation emits approximately 20 lbs of CO₂ or approximately 23 lbs if refinement and distribution are included (Glaser, 2008). Annually in the US, personal transportation accounts for approximately 136 billion gallons of gasoline, or 1.2 billion tons of CO₂ (Gotschi and Mills, 2008) which amounts to approximately one-fifth of global CO₂ emissions (Ewing et al., 2008).

Transportation accounts for one-third
of US CO₂ emissions

One-half of all car trips are less than
five miles (Mailbach et al. 2009)

The thirst for oil and consumption of fossil fuels is not expected to decrease. In fact, global transportation-related carbon emissions are projected to increase 80 percent by 2030 (Kahn et al., 2007). Although great strides have been made to increase the fuel efficiency of our fleet of motor vehicles, individuals are taking a greater number of trips and traveling farther to reach their destinations. The number of vehicle miles traveled (VMT) in the US has increased three times faster than population growth in recent decades (Gotschi and Mills, 2008)

Figure 6. Weekday Carbon Dioxide Emissions per Census Tract in Jefferson County, Kentucky



In order to reduce GHG emissions to a level that will help mitigate climate change, a multifaceted approach will be required. The paradigm of the past several decades has been to increase fuel efficiency in the hopes that it will offset our demand for oil and lessen our impact on the environment. However, it is clear from our predicament that increased fuel efficiency

alone will not suffice. Although technology spurred the industrial growth contributing to global climate change, technology alone will not be the solution. It is irrational to think of a solution to climate change that does not involve significant changes to our transportation system and takes a critical look at our commuting choices. If we are to get serious about sustainability, it is time for a paradigm shift. We must all understand that we are all participants in the global issue of climate change and must do our part to reduce dependence on burning fossil fuels. One way of making a significant impact is by biking locally (to work, school, and for other short trips); think globally, bike locally.

Carbon dioxide emissions from the transportation sector can be thought of as a three-legged stool: a function of vehicle fuel efficiency, fuel carbon content, and VMT (Ewing et al., 2008). Increasing fuel efficiency and finding alternative sources of fuel will be critical in developing an effective transportation program but one of the simplest things that can be done is to drive less. About half of all car trips are less than 5 miles (Maibach, 2009) which could instead be completed with a 20-minute bike ride.

External costs that result from increased fuel efficiencies (i.e., Jevons Paradox - increased fuel efficiency often yields increased VMT) and the many indirect benefits from travel reductions (i.e., less congestion, emission reductions, health benefits) are often excluded from analyses in programs aimed at reducing transportation related emissions (Litman, 2010). There are options! Local infrastructure, density, and spatial structure of the built environment influence the amount of potential GHG mitigation possible from reduced VMTs. For example, smart growth development patterns (i.e., increased density, walkability, etc.) can realize 35 percent less VMT than sprawling suburban-type growth (Ewing et al., 2008). Efforts to reduce CO₂ emissions by driving less can realize significant benefits. A 30 percent reduction in VMT could result in a 28 percent reduction in CO₂ emissions (Ewing et al. 2008).

Reducing the number of VMTs, using more fuel efficient vehicles, carpooling, using public transportation, chain trips, walking, and bicycling are all important components to reducing the overall carbon footprint of daily travel. However, it can be argued that none are more fun, exciting, and rewarding than riding a bike. A bicycle commuter who rides 5 miles to work, four days a week, avoids 2,000 miles of driving per year, which is the equivalent of 100 gallons of fuel saved and 2,000 lbs of CO₂ emissions avoided.

Such a savings would have approximately a 4 percent reduction of the average American's carbon footprint (Gotschi and Mills, 2008). Total savings that would result from shifting short trips to bicycling or walking could amount to 2.4 billion to 5 billion gallons of fuel or between 21-45 million tons of CO₂ per year (Gotschi and Mills, 2008). While bicycling may not solve the problem of climate change on its own, it has to be part of the solution.

One of the simplest things we can do to reduce our carbon footprint is to **drive less.**

If Biking is so Healthy, Why Don't more Americans do It?

In the University of Louisville Survey the vast majority of people drive a car alone from home to campus. Roughly one third of the students in the survey either walk, bike or take the bus. Many more students would like to ride a bike or walk to improve their health but are reluctant to do so because of the dangers perceived due to a lack of bike lanes. In addition the survey found that even more people would bike if they were given a free bicycle in exchange for not purchasing a parking pass. Some people argue that people don't bike because of the four-season climate is inhospitable to commuting by bike, but a comparison of Louisville to three cities known for biking weather does not seem to be a deterrent.

While the benefits of cycling are clear and undeniable, it is important to understand that there are risks associated with cycling as well. Cyclists are twelve times more likely to be killed than motorists (Delmelle and Thill, 2008). Louisville was recently ranked the seventh most dangerous city for pedestrians, which also serves as an indicator of bicyclists' safety (Transportation for America, 2010). According to the Kentucky State Police, there were 532 bicycle crashes in Jefferson County between January 1, 2006 and May 31, 2009, averaging about 165 accidents annually. Jefferson County had three bicycle fatalities in 2008 (Gowin, Countywide Countermeasures 02, 2010). That same year, the Kentucky State Police reported 489 total bike



Figure 7. Man and Woman Riding with Child

accidents resulting in six fatalities and 353 injured cyclists statewide (KSP, 2008). Half of the state's bicycle deaths occurred in Jefferson County (see Table 2. Kentucky and Jefferson County Bicycle - Automobile Collision Comparison 2008). While the disproportionate number of deaths within Jefferson County may be attributed to Louisville being the most populous city in Kentucky, it highlights the broader issue of the need for increased cyclist safety in Louisville.

Table 2. Kentucky and Jefferson County Bicycle - Automobile Collision Comparison 2008

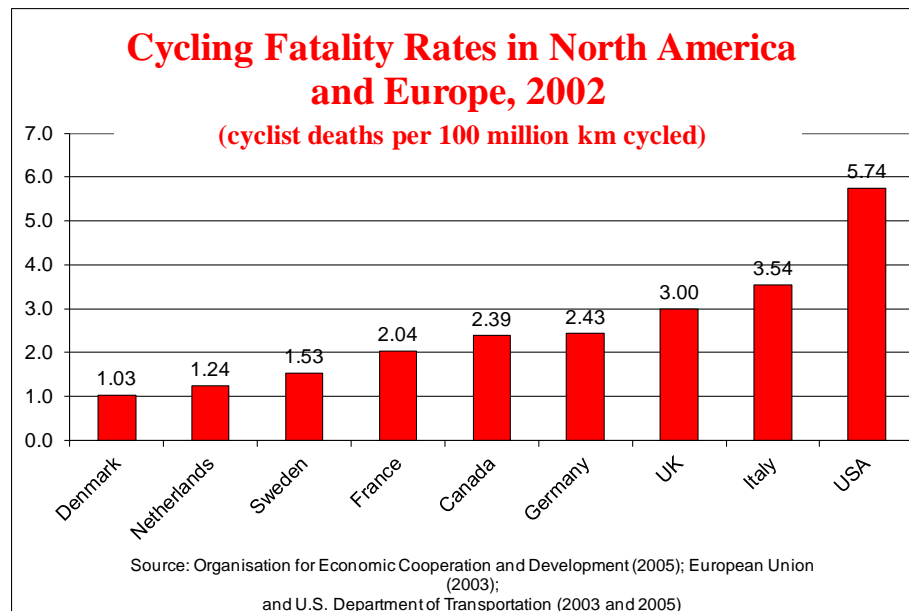
Location	Accidents	Injuries	Fatalities
Kentucky	489	353	6
Jefferson County	162	116	3

Sources: http://www.kentuckystatepolice.org/pdf/KY_Traffic_Collision_Facts_2008.pdf; Gowin, Countywide Countermeasures 02

A breakdown of the 2008 state data reveals that almost a quarter of bicycle injuries and half of the deaths were due to carelessness of the driver (KSP, 2008). For the same year, 14 percent of bicycle injuries were due to failure of the driver to yield the right-of-way (KSP, 2008). In Jefferson County, the angle turn collision type accounted for the largest number of bicycle accidents, with 241 crashes between January 1, 2006 and May 31, 2009 (Gowin, Countywide Countermeasures 02, 2010). Angle turn collisions may be the result of right or left hand motorist turns and occur when a driver turns into the path of a cyclist upon a right or left hand turn, often from not seeing the cyclist approaching the driveway or intersection. During the same time period, sideswipe collisions, where the motorist and cyclist are in the same direction, are the second most common accident type in Jefferson County. Thirty-nine sideswipe collisions occurred between January 1, 2006 and May 31, 2009 (Gowin, Countywide Countermeasures 02, 2010). These data suggest that improving driver attention and right-of-way adherence could reduce injury and mortality risk, thus improving safety for cyclists. Transportation design elements of the built environment contribute greatly to the above factors by influencing driving habits and bicycle safety.

The importance of the built environment is further illustrated by the fact that cycling in the US is more dangerous for cyclists than in the Netherlands, widely accepted as a bike-friendly city. US fatality rate per 100 million bike trips is 12.5 times higher than in the Netherlands. Additionally, the fatality rate per 100 million km traveled is also higher in the US than the Netherlands, with values of 7.2 and 2, respectively. A comparison of the injury rate per 500,000 km traveled reveals a considerable difference between the US and the Netherlands, 25 and 0.4, respectively (Pucher and Dijkstra, 2003); see Figure 6. Bicyclist Fatality and Injury Rate Comparison between the US and the Netherlands.

Figure 8. Bicyclist Fatality and Injury Rate Comparison between the US and the Netherlands



Bike Lane Collisions

Road design positively influences cyclist safety when it accommodates all users of the road – cyclists, pedestrians, and motorists. The presence of bike lanes in the road design designates space for cyclists on roadways, reserves sidewalks for pedestrians and therefore accommodates all users. Bike lanes use signs, color designations, and pavement striping to provide a visual indication to share the road, cautioning drivers that cyclists may be in the vicinity. However, there are critics of whether the presence of bike lanes reduces bicycle accidents or whether they do more harm than good. Lott and Lott (1976) compared roads with and without bike lanes and determined that roads with bike lanes had 53 percent fewer bike accidents. Moritz (1998) investigated the danger indices (number of crashes divided by commute distance) and found they were over twice as high for roads without bike facilities (i.e., provisions to accommodate cycling, like bike lanes) (Transportation Toolkit, 2010). A 2006 New York City safety report revealed that over the previous ten years, only one of 225 bicycle deaths had occurred in a bike lane (Mapes, 2009).

Figure 9. “Ghost Bike” in Louisville, Kentucky – site of Jen Futrell's fatal accident



Bike lanes are not a panacea. Smith and Walsh 1988, compared collision counts pre- and post-bike lanes, and found that there was an increase in bicycle collisions in the initial year following the bike lane addition. Bike lanes often are responsible for an increase in the number of cyclists because of an increased safety perception (Byrne, 2009), which may, in turn, contribute to an increased number of bike accidents. Depending on design, bike lanes can also present new dangers. Often, the bike lane is placed between the driving lane and the parallel street parking, which can create dangers for cyclists when car doors are opened. Bicyclists report that in trying to avoid a suddenly-opened car door, causing them to swerve into the driving lane, can lead to a cyclist-motorist collision. This area of a bicycle lane subject to the encroachment of the width of an opened car door is referred to as the door zone. For some cyclists, the door zone in bike lanes causes them to ride as close as possible to the driving lane to feel safest which, in some ways makes the bike lane less effective.

While discrepancies exist over whether bike lanes contribute to reductions in bike collisions, there is a general consensus that bike lanes at the very least increase driver awareness that cyclists may be present. The perception of safety goes a long way towards increasing ridership. If you do not believe us, listen to a rock music legend. In *Bicycle Diaries*, David Byrne reports that he feels safer in bike lanes because he is no longer as paranoid that a driver will swerve into his lane (Byrne, 2009).

Bike Lane Alternatives

Former Louisville Mayor Jerry Abramson instituted a policy to include bike lanes as a part of every road that is built or reconfigured in the city, with about thirty miles being striped so far (Mapes, 2009). 2010 Louisville Mayoral Candidate Jackie Green, an avid cyclist and local business owner, is among those who do not think we should stop there. He supports alternate bike facilities that would separate cyclists from the danger zones. Alternatives to bike lanes include cycle tracks, bicycle boulevards, and multi-use paths. These are described below:

- Cycle tracks are bicycle facilities similar to marked bike lanes but separated from the road by a physical barrier, such as a curb (Reynolds et al., 2009) which reduce the chance of motorists entering the path of the bike. Some however, argue against cycle tracks because they protect cyclists in the middle of the block, but not at intersections, where most bike collisions occur.
- Bike boulevards are “low-traffic streets that discourage all but neighborhood auto travel while providing good through routes for cyclists” (Mapes, 2009). They are streets to accommodate mostly bike travel instead of motorist travel through the use of traffic calming techniques (Dill, 2009). Utilizing stop signs placed on the intersecting streets of bike boulevards can be used as a traffic calming measure to allow bike traffic to flow through with limited motorist interruption. Additionally, bicycle boulevards sometimes have speed bumps with bicycle-sized cutouts to accommodate cyclists only.
- Multi-use paths are paved or unpaved off-road bike facilities shared between non-motorized users (Reynolds et al., 2009). Because they are completely separate from both motorists and the door zone, they too provide a safe alternative to bike lanes. Some research indicates an increase in the number of bicycle accidents on multi-use paths, but because of the slow speeds they result in less severe injury (Mapes, 2009; Rivara et al. 1997).

Cyclists who oppose the provisions of bike lanes or other bicycle facilities believe that cyclists operate best when they act and are treated as drivers of vehicles on roads (Mapes, 2009). Some believe that bike facilities such as bike lanes, cycle tracks and multi-use paths are used to simply keep cyclists out of the motorists' way (Mapes, 2009). As fervent bicycle-rights advocate John Forester states, “typical Americans believe that cyclists are inferior to motorists in legal status and in competence, that cyclists should defer to motor traffic, and that failure to defer to motor

Chapter: While the benefits of cycling are clear and undeniable, it is important to understand that there are risks associated with cycling as well. Cyclists are twelve times more likely to be killed than motorists (Delmelle and

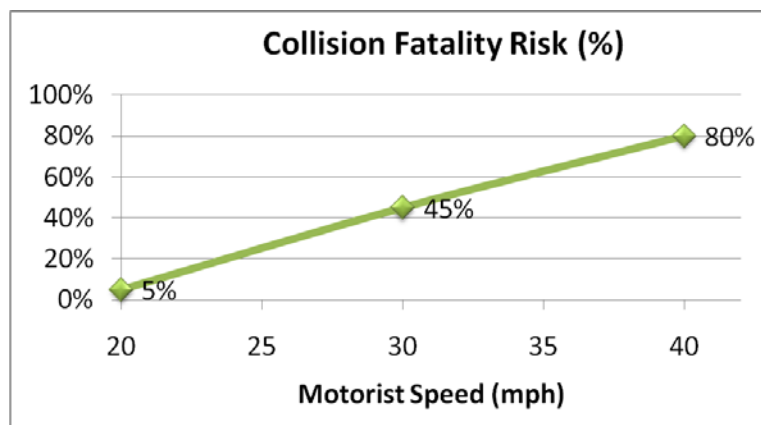
traffic is dangerous” (Forester, 2009). Whether you are an advocate for cycling infrastructure or feel that cyclists should act as motorists while on city streets, integrating cyclists and automobiles within the same transportation network will require provisions for users operating at very different speeds.

Collision Speed

The speed of motor travel on streets greatly influences bicycle safety, and is a clear giveaway that roads are not designed for the most vulnerable users, but instead for the motorist. As Dan Burden, a bike advocate, explains, “The human body is not designed to move faster than fifteen miles per hour. Our sight, our ability to interpret things, to process things, is bicycling speed” (Mapes, 2009). Klop and Khattak 1999 found that increased speed limits were associated with increased severity of cyclist injuries in accidents. Similarly, a study by Kim et al. 2005, found that the likelihood of severe injuries increases as vehicular speed increases and the fatality risk for cyclists more than doubles when motorist speed is above 30 miles per hour. If a cyclist is hit by a car traveling at 20 miles per hour, there is a five percent chance the accident will result in a cyclist fatality, but grows rapidly to 45 percent when the automobile is traveling at 30 miles per hour, and to 80 percent fatality at 40 miles per hour (see Figure 10. Bicyclist Fatality Risk Associated with Motorist Speed in Collisions.) (Gowin, Designing Streets for Bicyclists, 2010).

Reducing speed limits is one way to reduce motorist speed, although that would likely draw fierce opposition from motorists. Approaches to reduce speeds that would draw less resistance include reducing the number of lanes of traffic and/or narrowing the width of streets (Pedestrian and Bicyclist Intersection Safety Indices Final Report).

Figure 10. Bicyclist Fatality Risk Associated with Motorist Speed in Collisions



Source: Gowin, Designing Streets for Bicyclists; Pucher and Dijkstra (2003)

Collisions on One Way Roads, Riding Against Traffic, and Sidewalk Riding

One factor influencing traveling speed and bicycle safety is street design. Allen-Munley et al. 2004 found more severe cyclist injuries were reported in collisions on one-way streets than typical two-way streets (Reynolds et al., 2009). Wachtel and Lewiston 1994 reported that cyclists traveling in the wrong direction are 3.6 times more likely to have collisions than those following the direction of traffic (How Not to get Hit by Cars, 2009). Cyclists tend to ride against traffic on one-way roads, rather than accessing a more distant street route or busier arterial roads (Alrutz et al., 2002). Traveling against the flow of traffic is dangerous because motorist right turns from side streets could lead directly into the cyclist's path thereby increasing the chance of head-on collisions (Wrong Way Cycling, 2010; How Not to get Hit by Cars, 2009). In head-on collisions, the traveling velocity of the bike and motorist are combined, leading to a more forceful impact and increasing the likelihood of injuries than the cyclist would have encountered if flowing with the direction of the motorist (How Not to get Hit by Cars, 2009). Reducing the number of one-way streets and providing cycling network connections to desirable locations so that cyclists will not circumvent one-way street routes will reduce the likelihood of cyclists engaging in convenient, but unsafe travel. Watchel and Lewiston (1994) found that sidewalk riding is twice as dangerous for cyclists. If a car proceeds to make a right turn, the car may cross directly into the cyclist's path. Motorists do not expect to encounter bicycles in crosswalks and underestimate the speed at which bicycles travel, leading to disastrous consequences when they interact.

Survey Results and the Economics of Transportation

The Surface Transportation Policy Project, a nationwide coalition for safer communities and smarter transportation choices, has found transportation is an expense second only to housing. The average American household devotes 18 cents out of every dollar to transportation. In some metro areas, households are spending more on transportation than on housing. The vast majority of that spending (98%) is for the purchase, operation, and maintenance of automobiles. Some American families spend more on driving than on health care, education or food. The poorest families spend the most, sometimes in excess of one-third of their income. Estimates on how much the average person spends vary. The Surface Transportation Policy Project found that households in automobile-dependent communities devote 50 percent more to transportation (more than \$8,500 annually) than households in communities with multi-modal transportation systems (less than \$5,500 annually) (The Surface Transportation Policy Project, 2000).

Cost of Driving for Cities and Universities

The reliance on the car for transportation creates a heavy financial burden on the city. For universities and businesses, parking structures are an extremely costly venture. Steve Lawrence, associate vice president of Facilities Management at Central Michigan University estimated a cost of \$11,500 to \$13,000 per parking space in a garage, while a typical surface lot costs \$1,800 to \$2,000 per parking space (CML, 2005). Others estimate the cost of constructing one car parking space in a paved lot as high as \$22,000 and the cost of constructing one car parking

space in a garage to cost \$20,000 to \$30,000. Conversely, the cost to purchase and install one bike parking rack is approximately \$1,500 (Cascade 2010).



When evaluating the campus community's willingness to pay more for a U of L parking pass, the portion of the population already paying for premium parking passes expressed a willingness to pay even more. While 45 percent of standard pass holders would only be willing to spend another \$50 per year for a parking pass, 47 percent of those possessing a premium pass stated that they will pay any amount in order to continue driving to campus. Medium price parking passes show less extreme splits on their willingness to pay more (see Table 3. Willingness to Pay More for a U of L Parking Pass Before Finding an Alternative Means of Transportation).

Table 3. Willingness to Pay More for a U of L Parking Pass Before Finding Alternative Transportation

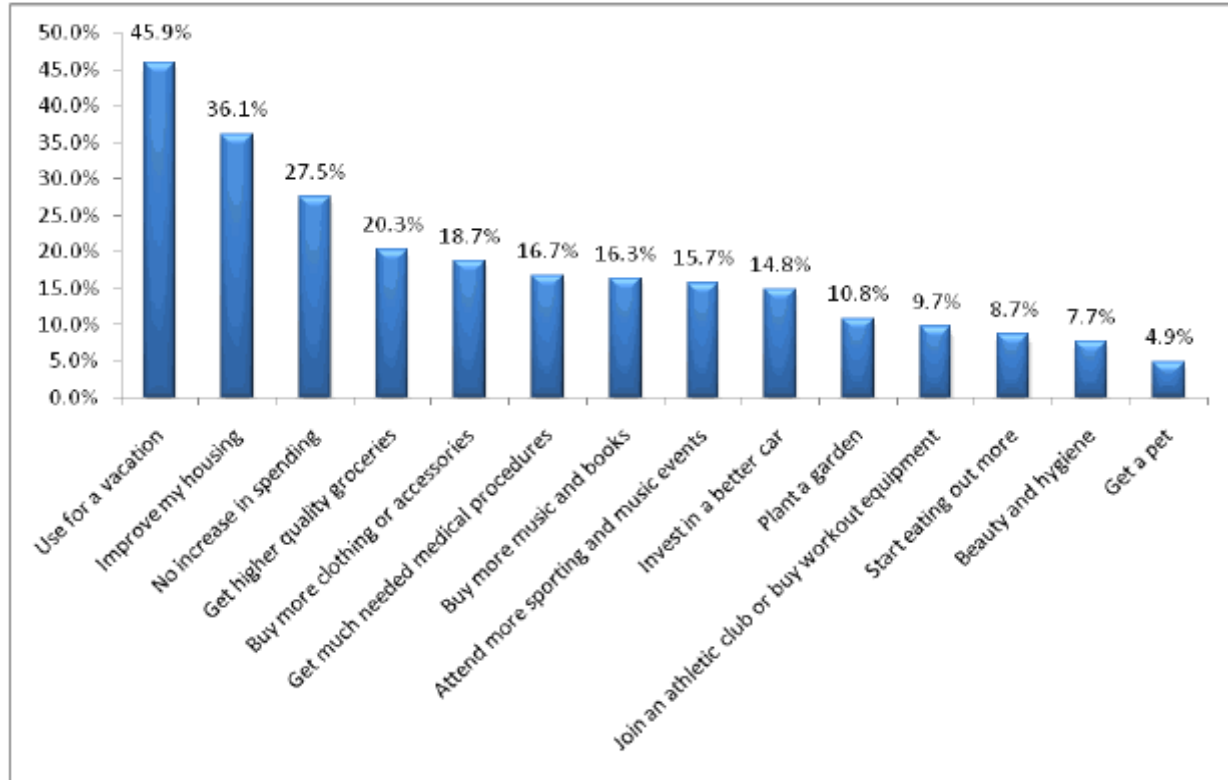
Permit Type	\$50	\$100	\$200	\$300	\$400	I will always drive to campus	Total
Red: \$562, 290 passes	19.7%	13.1%	10.0%	2.4%	7.9%	46.9%	290
Jewish Hospital Garage: \$361, 41 passes	39.0%	19.5%	7.3%	7.3%	12.2%	14.6%	41
Chestnut St. Garage Magenta: \$361, 113 passes	34.5%	19.5%	9.7%	7.1%	8.0%	21.2%	113
Blue: \$268, 395 passes	29.6%	15.9%	11.9%	8.6%	5.3%	28.6%	395
Yellow (resident): \$143, 41 passes	34.1%	22.0%	22.0%	0.0%	0.0%	22.0%	41
Green: \$126, 256 passes	50.4%	14.5%	13.7%	2.0%	1.6%	18.0%	256
620 HSC Garage Magenta: \$126, 156 passes	35.3%	18.6%	15.4%	8.3%	7.7%	14.7%	156
Purple: \$93, 107 passes	44.9%	23.4%	11.2%	3.7%	0.9%	15.9%	107

Source: U of L Transportation and Sustainability Survey 2010

Economic Benefits of Bikeable and Pedestrian-friendly Communities

Results of the University of Louisville survey found that one third of respondents would use money saved from commuting to improve their housing (see Figure 9. If savings were to be realized, what would you do?). As expected for homes with increased home improvement investments, homes in pedestrian-friendly communities to be more valuable. The willingness for consumers to spend more in walkable and bikeable communities stem from the economic tradeoffs associated with less reliance on automotive travel. The local economy would get a boost. One-fifth would use their savings to purchase better quality groceries or higher quality clothing. One sixth would buy more music and books, or attend more music and sporting events. One out of ten would plant a garden, work out more or start eating out more.

A 1999 study by the Urban Land Institute of four new pedestrian-friendly communities determined that homebuyers were willing to pay a \$20,000 premium for those homes compared to similar houses in surrounding areas (LGC 2000). In 2001, Charles Tu and Mark Eppli found that homebuyers are willing to pay more to live in new urbanist traditional neighborhood developments. They found the price premium to be 14.9 percent in Kentlands, MD outside of Washington D.C., 4.1 percent in Laguna West near Sacramento, CA, and 10.3 percent in Southern Village in Chapel Hill, NC (Tu and Eppli, 2001). A consumer's market radius is lessened when the means of transportation goes from auto to bicycling or walking, meaning a greater portion of their spending is done closer to their residence. When an individual or family saves anywhere \$1,000-8,000 annually by bicycling or walking to work, the saved money is available for other expenses. . John Matthews reports that microeconomic theory predicts that housing value is related to transportation costs. So as the distance to destinations like work, shopping or entertainment declines with less separation between uses and increased mixing, home value should increase (Matthews, 2006).

Figure 11. If savings were to be realized, what would you do?

Source: U of L Transportation and Sustainability Survey 2010

University populations have shown to be especially responsive to alternative modes of transportation. The 2008 American Community Survey data, an annual 1 percent sample of the U.S. population conducted by the U.S. Census Bureau, show that the top nine metropolitan statistical areas where individuals bicycle to work have a major state university as a major staple of its local economy (see Table 4. Means of Transportation to Work by Metropolitan Statistical Area). The areas are geographically, climatically, and economically diverse in nature, but all have a major state university with at least 17,000 students.

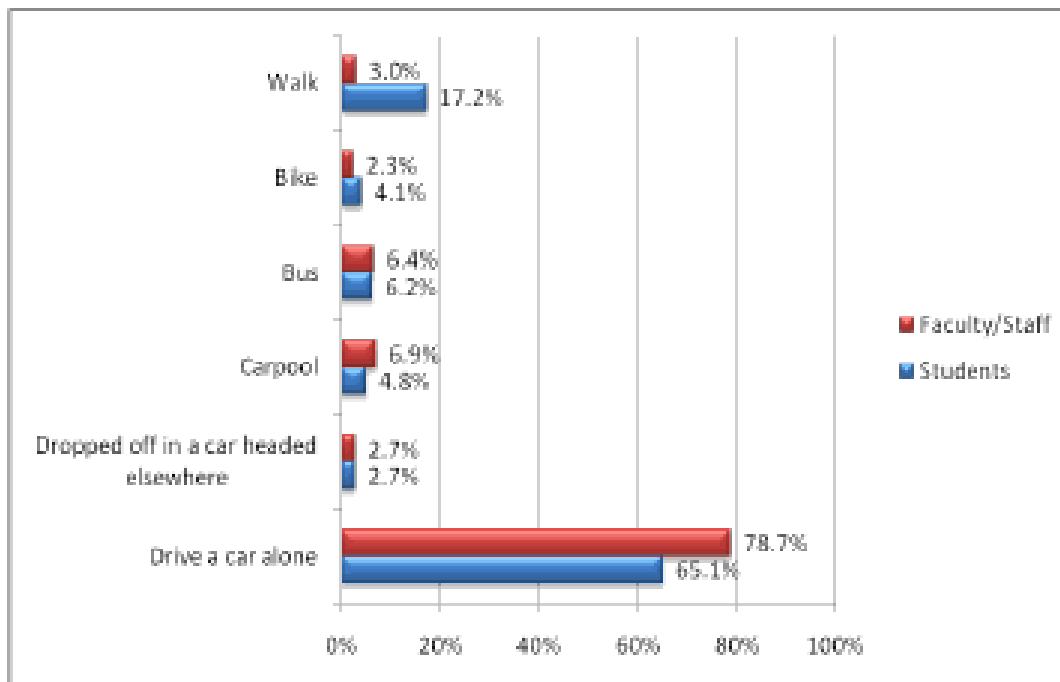
Table 4. Means of Transportation to Work by Metropolitan Statistical Area

Rank	Metro Area	Bicycling to Work (%)	Walking to Work (%)	Major University	University Enrollment
1	Yolo, CA	6.4	2.9	University of California-Davis	31426
2	Eugene, OR	5.0	4.7	University of Oregon	20376
3	Fort Collins-Loveland, CO	4.7	1.7	Colorado State University	31011
4	Flagstaff, AZ	4.0	6.6	Northern Arizona University	21413
5	Gainesville, FL	3.2	2.1	University of Florida	49679
6	Santa Barbara-Santa Maria, CA	3.0	4.1	University of California-Santa Barbara	21868
7	Chico, CA	2.7	3.2	California State University-Chico	17132
8	Santa Cruz, CA	2.4	2.8	University of California-Santa Cruz	16087
9	Bryan-College Station, TX	2.4	2.8	Texas A&M University	48702
10	Portland, OR	2.2	2.9	Portland State University	24284
153	Louisville, KY	0.4	1.7	University of Louisville	21016

Source: American Community Survey 2008

Currently Louisville ranks especially low for bicycling, walking, and other modes of non-automotive travel. Metro Louisville ranks 153rd of 284 metro areas in individuals who most often bicycle to work, 182nd in walking to work, and 188th in percentage using non-automotive means of getting to work (i.e., using public transportation, bicycling, walking, ferry, or working at home). Even within the University of Louisville community, the proportion of the population using alternative means of transportation to get to get to campus is alarmingly low (see Figure 10: Means of Transportation for Commuting at the University of Louisville). Only 4 percent of all students and 2 percent of faculty and staff bike to work on a regular basis. Among students, 17 percent walk to get to campus, including students living in university owned housing on or near campus. An overwhelming proportion of the population drives in a car by themselves. Nearly 80 percent of faculty and staff and close to two-thirds of the student population are commuting alone by car.

Figure 12. Means of Transportation for Commuting at the University of Louisville



Source: U of L Transportation and Sustainability Survey 2010

Promotion of Bicycling

U of L will demonstrate a model of good motorist/cycling relationships by supporting safe cycling infrastructure and classes for both cyclists and motorists. Education may provide the link to promote a more diverse transportation community in and around campus.

Louisville, like many American cities such as New York City and Portland has undertaken the challenge of luring and attracting new riders to their streets. The Metro Louisville government, as a part of the Mayors Healthy Hometown initiative, has developed some innovative approaches to get people onto bicycles. City-wide events such as the annual “Ride to Work Day” as well as the promotion of a cycling route called the “Louisville Loop” are examples of how the city has tried to increase ridership. However, these programs typically target recreational riders who still use a car to get to work and home.

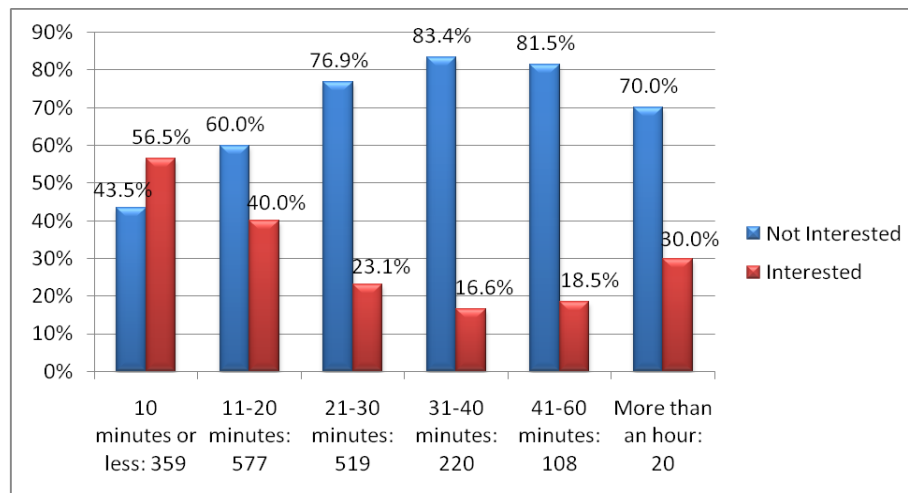


Ideas for Growing Bicycling and Marketing at U of L

The University of Louisville is a major stakeholder in increasing bicycling as a means of commuting to campus. Increasing livability, walkability, and bikeability around the campus and increasing property values would aid in the recruitment of students, faculty, and staff to not only enroll or work at the university but also live near the campus.

A real show of support for cycling as a means of transportation at the University of Louisville would be the creation of bike lanes for safe riding. Figure 10 shows a tremendous willingness among university faculty, staff, and students to consider biking to campus if a dedicated bike lane was provided from their neighborhood to campus. For students, 62 percent “strongly agreed” with the statement that if a dedicated bike lane was provided from the respondents’ neighborhood to campus, he or she would be more likely to bike to campus and another 22 percent “agreed.” Close to 80 percent of faculty and staff either agreed or strongly agreed with the statement (see Table 11: Among those who live close to campus, if a dedicated bike lane was provided from the respondents’ neighborhood to campus, he or she would be more likely to bike to campus).

Figure 13. Among those who Live Close to Campus, if a Dedicated Bike Lane was Provided from the Respondents’ Neighborhood to Campus, He or She Would be More Likely to Bike to Campus



Source: U of L Transportation and Sustainability Survey 2010

Conclusions

Louisville will be a stronger and smarter city when people adopt alternative forms of transportation. Skyrocketing gas prices and a troubled economy overall have prompted a demand for those alternatives. People are moving closer to their places of employment and schools in order to reduce their commute time.

Our report demonstrates that an increase in bicycle, pedestrian, and public transportation infrastructure will have numerous health, environmental, and economic benefits. With fewer cars on the road, we will increase active lifestyles, decrease CO₂ production, and save money. With healthier people in Louisville, employers will avoid absences due to illness and savings through lower health insurance costs. A cycling infrastructure is a key component of Louisville's larger “green investment” to attract businesses, bring economic growth, and increase employment opportunities. The increased savings from alternative forms of transportation will be invested within the local economy when people use those savings to improve their homes, buy local foods and patronize local businesses.



The University of Louisville would realize even greater benefits. It would save millions by avoiding the costs of additional parking facilities, attract healthier students, improve the health of current students, and retain more students. The city has announced that bike paths will connect Louisville's iconic Olmstead parks with the University of Louisville at its epicenter. Residents from all over the city will be able to bike to University of Louisville in a safe and affordable manner. Excellent universities possess infrastructure for bicycles and pedestrians. By providing more opportunities for alternative transportation, U of L has the chance to allow their students healthier and more productive lives.

With these changes Louisville and U of L could lead the south in its efforts towards sustainability.

Acknowledgements

We would like thank the following persons who were supportive and helpful of this project. Justin Mogg and Russ Barnett gave us the inspiration for this study. Thanks also to the Office of the Provost, Shirley Willihnganz and Vice President for Finance Larry Owsley helped grease the wheels to get the necessary approvals and allowed us to do an internet survey using the University of Louisville email base. We would also like to thank the Office of Institutional Research that gave us logistic support for the study and our thanks to the Institutional Review Board (IRB) for giving us an expedited review. Our thanks to David Simpson, Chair of Urban and Public Affairs, for allowing us to teach a graduate course on alternative transportation and being supportive of the class. The paper merged together papers written by students Natasha DeJarnett, Brian O'Neill, Zachary Kenitzer, Mike Misek, Jennifer Stephens, Mark Noll, and Janis Ebernez. Gregory Pucetti provided some important background on the history of biking. In writing this report, we wanted to make a case for increasing biking and its impact on our health,

environment and incomes. Some of the students listed might be disappointed that we did not use all or even some of their reports which came to a total of around 200 pages or so as we cut, expanded and revised the papers. After the grades were turned in, only three students expressed a strong interest in getting this published by doing a substantial amount of revisions: Natasha DeJarnett, Brian O'Neil, and Zachary Kenitzer. Subsequent revisions were done by students Jennifer Ewa and Hannah Hunt. The layout and design for the report was done by Natasha DeJarnett and Brian O'Neil with some additional assistance by Zachary Kenitzer. In early March we sent out the report to two professional editors Amy Barkley and Rick Redding to provide additional revisions for the report. Thanks to everyone and please: get out of your car and ride your bike more!

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