Making Dartmouth a Bike Friendly Campus



A Report by Environmental Studies 50 Environmental Problem Analysis and Policy Formation at Dartmouth College Spring 2014

Environmental Studies 50

Spring 2014 Section 1

Carly Carlin	Michael Perlstein
Katherine Cima	Clayton Pierce
FNU Cuomaoji	Emily Reeves
Meghan Duff	Nicholas Rooney
Monica Erives	Racquel Satterwhite
Hunter Foraker	Maya Schechter
Cathy Liebowitz	Isabella Terhorst
James Lin	Jose Valdovinos
Cheree Mills	Ronald Williams

Professor and Class Advisor: Professor Richard Howarth

Acknowledgements

We, the students of the Section 01 Spring 2014 Environmental Studies 50 course, would like to recognize the following people for their generosity and contributions during the formation of this report and for their assistance and guidance throughout this document's creation.

Michael Cox, Assistant Environmental Studies Professor at Dartmouth College
Robin Guay, Parking Operations Coordinator at Facilities Operations and Management Office
Rosalie Kerr, Director of Dartmouth College's Sustainability Office
Russell Hirschler, Executive Director of Upper Valley Trail Alliance
Richard Howarth, Professor of Environmental Studies at Dartmouth College
Jenna Musco, Sustainability Program Manager at Dartmouth College's Sustainability Office
Carolyn Radisch, Co-Founder of ORW Landscape Architects and Planning
Conrad Reining, Dartmouth College Board Chair at Upper Valley Trail Alliance
Joanna Whitcomb, Director of Dartmouth College's Campus Planning and Design

2013-2014 Dartmouth Community Members including Staff, Faculty, Undergraduate as well as Graduate Students and Community Allies

Table of Contents

ACKNOWLEDGEMENTS	3
TABLE OF CONTENTS	4
EXECUTIVE SUMMARY	
INTRODUCTION	10
SURVEY ON BICYCLE USE OF UNDERGRADUATE AND GRADUATE STUDENTS	12
PART 1A: ENCOURAGEMENT	14
INTRODUCTION	15
PURPOSE OF SOCIAL PERCEPTION SUBGROUP	16
Cyclists	16
Non-Cyclists	17
POP-UP BIKE SHOP	
BIKE SHARE PROPOSAL	
Benefits of a Bike Share Program	20
Solutions at other Campuses	22
A History of Bike Shares at Dartmouth	23
How it Works	24
Bike Share	24
Social Bicycles (SoBi)	25
The Market	28
Why It Will Work	30
Accountability	
Management	
Possible challenges of implementation	32
Background	33
Target Demographic	
Barriers to Bike Commuting	
Current Bike Commuter Programs at Dartmouth	
ZAP BOX COMMUTER INCENTIVE PROGRAM	
BETTER BIKE FACILITIES: COVERED BIKE RACKS AND SELF-SERVICE STATIONS	
THE DARTMOUTH BIKE REPAIR SHOP	
HEALTH AND WELLNESS INCENTIVES	
IDEAS FOR A REIMBURSEMENT PROGRAM	
INSURANCE DISCOUNTS FOR CYCLISTS	
PARTNERING WITH WELLNESS WORKSHOPS	
Social Incentives	51
BIKING EVENTS AND BIKE BUDDY SYSTEM	53
PART 1B: ENCOURAGEMENT FOR ALTERNATIVES TO STUDENT PARKING AT	
TRANSPORTATION HISTORY	
PROBLEM IDENTIFICATION	60
KECOMMENDATIONS FROM UTHER SCHOOLS	
DATA GATHERING	63
ANALYSIS OF CAMPUS PARKING	64

Possible Solutions	
CONCLUSION	71
ENCOURAGEMENT CONCLUSION	
PART 2: EDUCATION	73
Ευμερικά Ιντρομιστίον	74
Green Commute: What was useful what was not	75
New Website Content	75
New Websile Content	
Bike Koules Aloulle UV	
Incentives	
Bike Forum	
Current Situation	
Maintenance	80
Bike Maintenance and Bike Policy	
Bike Registration	
Management	
Advertising	
BIKE MAINTENANCE WORKSHOP	
The Host	
Costs	
Bike Repair Stands	
Lesson Plans/Curriculum	
Introductory Bike Workshop	
Bike Maintenance Workshop	
Future implications	
Advertising	
Curriculum	
Costs	
Advertising and Promotion	
BICYCLE RENTAL EDUCATIONAL COMPONENT	
Current Rike Rental Program	98
Additional Education Component	90 98
Advartising	
Auverusing	100
EDUCATION CONCLUSION	
PART 3: ENGINEERING	
ENGINEERING INTRODUCTION	
TABLE OF POTENTIAL SOLUTION DESCRIPTIONS	
GENERAL SUGGESTIONS	
Install Bike Route Wayfinding Signage	
Improving Intersections	
Use Shared Lane Markings, or Sharrows, at Intersections	
Protected Intersections	
Speed tables	
South Side of Green—East Wheelock Street	
East Side of Green—College Street	
West Side of Green_North Main Street	
College Street to LSC	
Convert Dirt Path on the East	
Paint the Road Shoulders Green	
Massachusetts Row	
Suggestion Bike Lanes and Paint Sharrows	
Replace Automobile Barriers	
I UCK Drive	

Paint Sharrows and Suggestive Bike Lanes	
Thayer Drive	
Add Sidewalks	
Painted Rike Shoulders and Sharrows	
Speed Table	
East Side of Campus—South Park Street	
East Side of Campus—East Wheelock Street	
Short-Term Parking	
Front of Class of 1953 Commons	
Collis porch & left side of Robinson Hall	
Front and back of Robinson Hall	
Patio between Robinson Hall and Collis	
Front of the Hopkins Center	
Entrances to Dartmouth Hall	
Steps of Fairchild	
College St. Entrance to Steele	
Front and sides of Baker	
Outside of Novack	
Alumni gym	
In front of Cutter Shabazz/ Sustainable Living Center	
Outside of Feldberg	
Ripley, Woodard, Smith	
Front of McNutt	
Moore	
Outside River Apartments	
Sides of Gile, Lord, Streeter	
Outside Rockefeller Center Overhang	
Top of the stairs on lower Tuck Drive	
Tuck entrance to Silsby	
Sudikoff	
LONG-TERM STORAGE	
Overview	
Causes of Outdoor Storage	
Proposed Improvements	
To disincentivize improper storage:	
RIKE MAINTENANCE	134
Current State of Rike Maintenance Availability at Dartmouth	134
The Sustainability Office's Pon-Un Rike Shon	134
Analysis of Relevant Survey Data	
Suggested Improvements	
Permanent Bike Repair Stands	
Permanent Full-Service Bike Renair Shon	
Engineering Conclusion	
CONCLUSION	
APPENDIX 1: SUMMARY OF SURVEY RESPONSES	
STUDENTS WHO BIKE AT DARTMOUTH FREOUENTLY	
STUDENTS WHO BIKE AT DARTMOUTH RARELY	
STUDENTS WHO DON'T HAVE A BIKE AT DARTMOUTH	
BIKE MAINTENANCE AT DARTMOUTH	

BIBLIOGRAPHY		59
--------------	--	----

Executive Summary

The purpose of this report, written by Professor Richard Howarth's Spring 2014 Environmental Problem Analysis and Policy Formulation class, is to outline an array of the best options available to make the college more "Bicycle Friendly." This goal was inspired by the Bicycle Friendly University (BFU) certification run through the League of American Bicyclists, who define a "Bicycle-Friendly University" as one proficient in five subsections, which The League calls the "5 E's", described below:

- 1. Engineering: Creating safe and convenient places to ride and park
- 2. Education: Giving people of all ages and abilities the skills and confidence to ride
- 3. Encouragement: Creating a strong bike culture that welcomes and celebrates bicycling
- 4. Enforcement: Ensuring safe roads for all users
- 5. Evaluation & Planning: Planning for bicycling as a safe and viable transportation option

In this report, we determined that in order to make Dartmouth's campus more "Bike-Friendly", it is most appropriate to focus the College's immediate efforts on Encouragement, Education, and Engineering. Each subsection proposes a range of opportunities for improvements to our campus, and we believe that a combination of these suggestions is necessary for a robust strategy.

- The Encouragement Section analyzes the current bike culture on this campus and focuses on three main proposals for improvement.
 - We propose the implementation of **a bike share program**, using a system that integrates bike share technology built into the bike itself, and an incentive program to support its adoption by students.
 - We recommend a comprehensive set of benefits for commuting faculty and staff, including a permanent bike repair shop, health and wellness programs, and social benefits and incentives.
 - We suggest policy changes that would discourage automobile parking for students living on-campus through stricter regulations and fees, and subsidies for Zip Car membership.

- The Education Section focuses on four main proposals in response to the lack of organized educational resources for biking on campus.
 - We recommend the creation of a new user-friendly and informative website, building on the Green Commuter website and aggregating other resources already available.
 - We propose **regular bike maintenance workshops** that would run through the permanent Bike Shop proposed in the Encouragement section.
 - We propose a **PE course** offered to students and community members, which would focus on bike care and riding safety skills.
 - We suggest that students must attend an overview class about bike care and safety in order to be eligible to rent a bike through the Office of Sustainability's rental program.
- The Engineering Section summarizes the current state of biking infrastructure at Dartmouth, describes problems with this infrastructure, or lack thereof, and prescribes solutions to make Dartmouth a more bike-friendly campus.
- We suggest solutions for specific roads, intersections, and paths that will facilitate easy and safe bike transport to and through Dartmouth's campus.
- Our **proposals** include painted bike lanes, painted bike shoulders, shared bike lane arrows, shared use paths, bike suggestions lanes, speed tables, and bike route way finding signage.
- We offer our recommendations for **bike storage options** including new covered bike racks of various designs, as well as accessible maintenance stations and long-term indoor storage.

While we understand that implementing all of these changes may not be feasible, we believe that a combination of these suggestions would vastly improve Dartmouth's bike culture and environment. If adopted, these strategies would not only meet many of the requirements of a certified BFU, but also increase the mobility and safety of students, expand students' skill sets and knowledge of bike maintenance and safety, reduce bike waste, decrease Dartmouth's environmental footprint, and create a visible commitment to sustainability.

Introduction

Environmental Studies (ENVS) 50, "Environmental Problem Analysis and Policy Formation", asks students to "formulate and justify policy measures that they think would be appropriate to deal with a local environmental problem."¹ Under the guidance of our advising Professor, Richard Howarth, we, the students of ENVS 50, have investigated biking on Dartmouth's campus, and have identified ways in which the College can encourage and improve cycling at and around Dartmouth as part of a larger campus movement towards sustainability. To that end, we were asked by the Dartmouth's Sustainability Office and Office of Campus Planning and Design & Project Management at the outset of this course to answer the following questions:

- 1. "Should Dartmouth apply for formal certification under the Bicycle Friendly University (BFU) program sponsored by the League of American Bicyclists?"
- 2. "If so, what issues and barriers would need to be addressed in order to file a successful application by the pending deadline of August 6?"²

In order to address these questions, our class has researched the current state of cycling on campus for students and commuters, evaluated the requirements to become a certified Bicycle Friendly University, and ultimately provided recommendations to improve cycling at Dartmouth. To do so, we have employed a framework provided by the League of American Bicyclists. This framework, "the 5 E's", was designed to help communities (including universities and municipalities) understand, measure, and improve bicycling in a given location. The 5 E's has proved an extremely useful tool in examining cycling at Dartmouth, and our class has chosen to implement the 5 E's in the framing of our recommendation. The E's are as follows (taken directly from the League of American Bicyclists)³:

- Engineering: Creating safe and convenient places to ride and park
- Education: Giving people of all ages and abilities the skills and confidence to ride

¹ Text from ENVS 50 ORC description ² Text from ENVS 50 Syllabus. Howarth 2014.

³ "The 5 E's." *League of American Bicyclists*. N.p. Web. 21 May 2014. http://bikeleague.org/content/5-es/

- Encouragement: Creating a strong bike culture that welcomes and celebrates bicycling
- Enforcement: Ensuring safe roads for all users
- Evaluation and Planning: Planning for bicycling as a safe and viable transportation option

Given our context as a college campus (rather than a municipality with legal jurisdiction), our class has focused our investigative efforts specifically on Engineering, Education, and Encouragement and has provided recommendations within these spheres (though many touch on aspects relevant to Enforcement and Evaluation).

We have employed myriad research methods in order to produce this report. Our methods include discussions with local experts, examination of best practices from other universities and bike-friendly communities, interviews with students, faculty, and staff (spanning the range of attitudes towards cycling), and surveys of undergraduate and graduates students. Local experts interviewed include Rosi Kerr, Director of Sustainability at Dartmouth; Joanna Whitcomb, Director of Campus Planning; Carolyn Radisch, local architect and urban planner with ORW Architects; Conrad Reining and Russell Hirschler, Board Chair and Executive Director of the Upper Valley Trails Alliance, a local nonprofit involved in bike advocacy; and Michael Cox, Assistant Professor of Environmental Studies. The information gained in these discussions, interviews, and surveys, as well as our investigation of collegiate and municipal policy, forms the basis of our understanding of the current state of cycling at Dartmouth. To that end, we would like to now present relevant data from our survey (which can be found in its entirety in Appendix A) in order to establish a fundamental understanding of cycling at Dartmouth.

Survey on Bicycle Use of Undergraduate and Graduate Students

In order to gauge student practices and attitudes towards cycling, our class surveyed undergraduate and graduate students via an online questionnaire distributed to campus. Supplementary questions addressed issues of convenience, ability, maintenance and safety for biking around campus. Responses from 390 students reported that only 19% of participants bike daily or almost daily, 16% bike a few times a week, 18% bike rarely and 47% of participants don't have a bike.⁴

Students Without A Bike

- Those participants who don't have a bike at Dartmouth reported their level of confidence on a scale of 1-5 with 30% of students at a 5, or fully confident, 25% at a 4, 23% at a 3, 15% at a 2 and 7% at a 1.
 - Ability is not the main reason for not feeling comfortable biking for those who do not have a bike, as 30% reported bike theft as the main reason they do not feel comfortable biking at Dartmouth, followed by not feeling confident in ability, bike maintenance and lastly safety.
 - 67% of study participants without a bike on campus have used a bike before attending Dartmouth; the top reason for not biking on campus is that it is more convenient to walk than bike around.

Students Who Rarely Bike

- 29% reported confidence in biking ability 5 out of 5, 49% at a 4, 15% at a 3, and 4% each for a 2 and a 1
 - The top reason for feeling less than comfortable biking at Dartmouth is bike maintenance, followed by bike theft, safety and lastly not confident in their ability.
- 36% of rare cyclists at Dartmouth selected that it's more convenient to walk than bike around campus; bike maintenance was the second reason at 23%, followed by 15% concerned about bike theft.

⁴ ENVS 50 Class. "Student Biking at Dartmouth." Survey. April 2014.

• Rare cyclists at Dartmouth reported their preference of where to ride at, and 31% chose bike lanes on the road while 27% chose bike lanes on the sidewalk, 19% of rare cyclists chose a separate bike path, even if the route was less direct.

Students Who Bike Frequently

- 86% of frequent cyclists rated a 4 or 5 on the confidence scale. However, when asked what would discourage biking on campus 32% of frequent riders marked safety as their primary concern, 28% reported bike maintenance and 25% by bike theft.
- For frequent cyclists, 50% of participants primarily use the road while 44% use sidewalks and only 4% use designated bike lanes.
 - When asked for their preference, 41% would rather bike on a designated bike lane in the road.

This data provides some framework for the current culture at Dartmouth, as our report attempts to increase biking on campus through safety awareness, specific bike lanes and incentives for biking.

Part 1A: Encouragement

Introduction

In order to create a positive and prosperous bike culture at Dartmouth we must encourage many social and behavioral changes. There are many ways the College can bring about changes that would not only make it easier for current community cyclists to get around, but also ways of attracting new cyclists through various Encouragement projects. According to the League of American Bicyclists, "Communities, businesses and universities play a critical role in encouraging people to ride by giving them a variety of opportunities and incentives to get on their bikes."⁵ We see Dartmouth College as having the potential to be a leader in becoming a Bike Friendly Campus and Community. Encouragement examines social norms and perceptions surrounding biking and tries to shift stereotypes via programs and incentives to foster a more inclusive cycling community.

We focused our work on Encouragement into three main topic areas:

- 1. Social perceptions of biking in Dartmouth's undergraduate population
- 2. Bike share programs at Dartmouth and peer institutions
- 3. Student and commuter incentive programs

The third section also examines parking regulations at Dartmouth and makes suggestions for how the College can reduce the number of drivers on campus and look for alternative modes of transportation, specifically biking. One component of the incentive section proposes the idea of the Zap box program, modeled after the University of Minnesota's bicycle program, which involves installing solar-powered boxes that electronically log the distance people bike and create a platform for people to compete with one another and receive benefits for biking. Throughout our interviews and research regarding encouragement and social behavior, we have discovered that the best way to attract new cyclists is to incentivize them in a positive way until they begin to see the benefits of biking themselves and are motivated to stick with it. The following chapter outlines findings from social surveys of campus climate, Bike Share proposals, and incentive programs.

⁵ "The 5 E's." *League of American Bicyclists*.

Purpose of Social Perception Subgroup

The purpose of our encouragement subgroup is to attempt to uncover any social stigmas and reasons that would limit students from riding a bike on Dartmouth's campus. Like many other college campuses around the nation, Dartmouth College has taken various efforts to reduce its environmental footprint. However, there seems to be little emphasis on the cultural or human dimensions of environmental sustainability, especially concerning the behavioral aspects of campus biking.

These cultural and behavioral aspects of students are important because they serve as insight into whether the student body of Dartmouth has a dominant bike culture, and they also help specify what stigmas potentially limit students from campus commuting via bike. These areas of insight would be crucial to know as we implement incentives for students to commute on campus and as we go about deciding what events and activities would raise awareness regarding biking, mainly by portraying it as a convenient, efficient, and "cool" thing to do.

We approached this task by developing interview questions for two groups: Cyclists and Non-Cyclists. Our purpose in interviewing students about their biking habits was to better understand why students choose to, or not to, ride bikes as opposed to other forms of transportation.

Cyclists

For the Cyclist group, we interviewed an equal number of females and males commuting around campus and the town of Hanover, most of whom are upperclassmen from the classes of 2014 and 2015. The following represents questions we asked during each individual interview.

Though the sample size is small, we feel that it is representative of the greater Dartmouth undergraduate population. Their responses are useful because these subjects have opted to use a bike despite any underlying connotations about biking at Dartmouth, shedding light on the factors that incentivize cycling. Below are some of our major findings:

• The interviewed subjects use their bikes for many short trips around campus, but commuting to a distant endpoint was the most frequent answer. Alumni Gymnasium, local businesses in town and the Coop were emphasized locations for which these

subjects frequently use their bike. However, travelling from class to class is also important.

- These subjects viewed biking as a method to save time. This subgroup of individuals "like being prompt" and are busy students. There are circumstances when the cyclists prefer to walk, but use their bikes when they feel busiest. These students enjoy biking and recognize the efficiencies that biking can provide to their day.
- There were diverse responses to the question of what their personal perceptions are of students who commute around campus by biking. Most subjects took a neutral stance about cyclists saying that those who bike are "just normal students," while others had different perceptions. One subject perceives students who bike as "sustainable people" and guesses that these students also partake in other sustainability initiatives around campus. Another categorizes these students as undergrads who desire to be efficient. None of the cyclists have a negative perception of cyclists or biking around campus

These cyclists identified how they believe other students perceive them. The most frequent response was that there is likely frustration because cyclists impede pedestrian flow. The answers to this question show that these students are not very aware of any negative social perception of cyclists.

Finally, most of these interview subjects bike alone when utilizing their bike. Some have commuted with company via bike and reported that this was not difficult from a social or logistical point of view. Most, however, noted that their friends do not have bikes or that it is too difficult to coordinate biking with friends for various reasons. Biking in groups can be awkward and dangerous so most of these students choose to bike for efficiency reasons other than social.

Non-Cyclists

In this demographic, slightly more women than men were interviewed about their biking habits. For class representation, there are a variety of students from each class, ranging from the graduating class of 2014 to the class of 2017. The following represents questions we asked during each individual interview.

Most students interviewed prefer walking for several reasons. First, they do not have access to a bike that works. Second, they reason that biking is a hassle because of the need to maintain and store the bike during daily use. Many students feel that there is really no need to own a bike on campus because of Dartmouth's small size. A minority of students report that they enjoy the leisure activity of walking rather than biking, or that there is a downside to biking where they cannot interact with friends in a group as compared to walking.

A majority of interviewed students report that they do not have any important perceptions about students who bike around campus. However, many think cyclists are busy people that need to get to places quickly, and that generally they are independent people. A minority of students also thinks that cyclists are generally athletic, outdoorsy people associated with the DOC. However, there is also a very small contingent of students that does have a negative association with cyclists, either that they pose danger to walkers out in public or that they look nerdy and "uncool." A majority of students stated that there are no social perceptions limiting them from riding a bike around campus. However there is a minority that stated they still wouldn't bike, mostly because of convention. For women, it would be difficult to wear a skirt or dress and to interact with friends they run into if they were to ride a bike over walking. Lastly, a very small minority did mention looking "uncool" as a deterrent for them to ride a bike.

Pop-Up Bike Shop

Along with our interviews with students on campus, we wanted to include another perspective through the Dartmouth Pop-Up Bike Shop. Established in 2011 and funded by the Office of the Provost under the Office of Sustainability, the Pop-Up Bike Shop collects unwanted or broken bikes and repairs them to either sell to students or to rent for a selected term. They currently sell bikes at the Sustainable Moving Sale and demand has been impossible to meet. The majority of the time, 10-20 bikes are repaired for the Sale and sold very quickly. They also host bike repair hours at various times throughout the year, determined by weather and availability of the interns. These are usually held on the lawn of Robinson Hall.

Incoming freshmen that wish to own a bike purchase bikes in their fall term, but are often not given the resources to know how to store and maintain them. In some cases, these students lock their newly purchased bikes to a short-term storage rack. The bikes are then forgotten about, and often abandoned or hit by a snowplow. The rental program that is run through the Office of Sustainability is useful for students to rent a bike for a single term and leave campus without further thought.

Bike Share Proposal

Benefits of a Bike Share Program

A bike-share program is a network of bicycles available to the general population of a city or university. Participants buy a membership for a specified time period, giving them access to any bicycle within the system. At Dartmouth, a bike-share could offer our campus a number of real, tangible benefits to students by improving transportation, promoting health, and establishing a clearly visible commitment to sustainability.

One of the major advantages of a bike share is the increase in student mobility on campus and the enhancement of transportation within the Hanover area. Because Dartmouth has a relatively small campus, many of the trips using this program would be shorter distances from one building to another. According to our 'Bike Share' survey, 59% the students polled claimed they would use the program to travel from one class to another, 38% said they would use it for exercise or recreation, and only 3% said they would use it for traveling outside of Hanover.⁶ Because many of these rides would be spontaneous and rather quick, the shared bikes would have high turnover, increasing the chance that sufficient bicycles will be available to meet student demand. Additionally, a bike share system could simplify student travel and increase access to off-campus houses as well as community events at local businesses or facilities 'farther' from the main campus, such as Boss Tennis Center, Leverone Fieldhouse, Scully Fahey Field, and Thompson Arena. Such extended access could increase student participation in these events, boosting campus moral and unity.

Transportation could also be improved through a bike share by enhancing parking and storage, and decreasing theft. In our 'Student Biking at Dartmouth' survey, out of the 390 undergraduates who responded, 57% of the 'Students who Rarely Bike' said that they were 'less than comfortable' biking at Dartmouth primarily because of bike maintenance and theft. Out of the 'Students who don't Have a Bike at Dartmouth', 55% claimed that maintenance and theft were also their main disincentives.⁷ Our proposed bike share would address problems of maintenance and theft by providing a locking system attached to the bike itself (see below) and established bike hubs. Additionally, the bike share program would ideally reduce the number of

⁶ ENVS 50 Class. "Bike Share." Survey. April 2014.

⁷ ENVS 50 Class. "Student Biking at Dartmouth." Survey. April 2014.

individually owned bikes on campus, decreasing the need for winter bike storage. Also, because our bike share is a convenient and reasonably priced alternative to driving around town, down town traffic congestion and demand for parking would decrease, improving access to businesses and events. Furthermore, because the majority of transactions in the bike share are automated, there is no need for on-site staff and bicycles can be returned to multiple locations.

Aside from advancements in transportation, a bike share system comes with numerous health benefits. Because a bike share system is more affordable than buying, storing, and maintaining a personal bicycle, our program would expand the biking community at Dartmouth to those in need of a less expensive alternative. For this reason, in addition to the previously mentioned transportation benefits, bicycling would become a regular part of people's lives in new ways. Regular cycling, even at a slow pace, improves heart health, muscle tone and coordination, reduces stress and helps keep weight under control.⁸ We believe these health benefits would appeal to Dartmouth's many fitness-conscious students. What's more, some studies have shown correlations between an individual's level of physical activity and his or her workplace productivity.⁹ Thus, by increasing levels of exercise on campus, a bike share could potentially boost students' classwork and homework efficiency.

The implementation of a bike share system at Dartmouth would also act as a visible statement of Dartmouth's commitment to sustainability. Bike shares as an alternative to driving can help decrease traffic congestion, reduce fossil fuel emissions, and lessen the demand for motor vehicle parking supply. A bike share could also help decrease the amount of bike waste on the Dartmouth campus. The Dartmouth Facilities Operations and Management Department finds and disposes of approximately 120 broken and abandoned bikes per year, resulting in both environmental and labor costs.¹⁰ Assuming that many of students who abandon these bikes want the option of a bike on campus but do not have the incentive or means to store or care for it, a bike share system could help decrease the number of waste bikes by dissuading this specific demographic from purchasing personal bikes.

While the environmental benefits of a bike share are significant on a larger scale, the visible statement of sustainability that accompanies our proposed system could greatly impact

Transportation Division, 2009. Print.

⁸ Eisenberg, Sheryl. "Bike Sharing: Coming Soon to a City Near You." This Green Life (2013).

⁹ Schmidt, Jack, et al. Bike Share Opportunities in New York City. New York, New York: NYC Department of City Planning,

¹⁰ R. Kerr. Personal interview. April 29, 2014.

Dartmouth's image as a 'green' leader. Bike share programs in cities and universities all around the world have been met with overwhelmingly positive responses and feedback from both the media and general public.¹¹ Thus, the physical presence of a bike share on Dartmouth's campus could improve the public perception of our school in terms of environmentalism and overall quality of life (potentially increasing the number of applicants). Furthermore, the visibility of a bike share system could help change social behaviors on campus. Because the bikes and docking stations would be frequently seen all over campus, the popularity of the bike share system is likely to increase rapidly. Once using the bike share becomes a common practice, students will have the social incentive to join their peers in biking as a main form of campus transit.

Because of these many benefits, we believe that many Dartmouth undergraduate and possibly graduate students will choose to participate in such a program. In fact, of the 160 students that responded to our 'Bike Share' survey, 75% said that if there were a bike share at Dartmouth, they would be interested in participating. Furthermore, according to our "Student Biking at Dartmouth" survey results, some of the biggest disincentives for biking on campus include storage, maintenance, convenience (walking as an alternative), and theft.¹² As previously explained, our proposed bike share system will help eradicate these issues and thus encourage those originally bike-skeptical students to participate.

Solutions at other Campuses

Many colleges of comparable size to the Dartmouth campus, which covers 237 acres, have successfully implemented bike share systems. ¹³ At Bowdoin College, which sits on 205 acres, students have designed and developed the 'Yellow Bike Club' bike share program. ¹⁴ To join, students pay \$20 for a term long membership or \$30 for a yearlong membership, allowing them access to a fleet of used bicycles (painted yellow) as well as maintenance and storage. ¹⁵ While this system is environmentally friendly and inexpensive to implement, the Bowdoin Yellow Bike Club has suffered from theft and lack of accountability due to poor locking systems and the absence of GPS tracking devices on the bicycles.

¹¹ Schmidt, Jack, et al. Bike Share Opportunities in New York City. New York, New York: NYC Department of City Planning, Transportation Division, 2009. Print.

¹² ENVS 50 Class. "Bike Share." Survey. April 2014.

¹³ "Campus Planning and Facilities." 2014. Web. < http://www.dartmouth.edu/~cpf/>.

¹⁴ "Landscaping at Bowdoin." 2014.Web. Bowdoin College. https://www.bowdoin.edu/sustainability/buildings-grounds/landscaping.shtml.

¹⁵ "Bowdoin Yellow Bike Club." 2013. Web. Bowdoin College. http://students.bowdoin.edu/yellow-bike-club/.

A student group at University of Vermont, which has a slightly larger campus area of 460 acres, has set up a bike sharing system called BUG (Bike User's Group) bikes.¹⁶ In order to participate in the program, students register in person and provide their school ID. Students are then given access to a specific bike that they can use for up to two hours free of charge before they must lock it to one of the three bike rack 'hubs' on campus.¹⁷ While this system is quick and easy to sign up for, it lacks convenience as the bikes can only be returned to three locations on the entire campus and the key must be given back to the main student center information desk after two hours.

Yale, which covers 310 acres and has a similar campus-centered atmosphere as Dartmouth, has organized a bike share system alongside the company Zagster.¹⁸ This bike share company has provided Yale with 50 new bicycles and 10 bike-parking pods. Students can register for annual membership online for a \$20 fee and these members can be reimbursed if they take a bike safety class offered by the school. Rentals are \$3/hour or \$24/day. Yale students can reserve bikes via Zagster's mobile site or by texting Zagster from the bike's location. Additionally, students are held accountable for their rented bikes because members are required to give a credit card number and Yale email when registering.¹⁹ While this system seems very plausible at Dartmouth, one downside of Yale's bike share is that the bikes must be returned to the same location from which they were reserved. Because students at Dartmouth often operate based on convenience, the process of returning bicycles across campus might discourage students from participating in the bike share program.

A History of Bike Shares at Dartmouth

There have been multiple attempts to implement a bike-share program on Dartmouth's campus, yet none have used the necessary amount of capital required to ensure accountability.

In 2000, the Student Assembly used a budget of \$2000 for "Big Green Bikes", a program in which 50 bikes were provided for student use. There was no locking system on these bikes, and subsequently, the bikes were damaged or lost within a few weeks.

¹⁶ "Transportation and Parking Services: UVM." 2014.Web. University of Vermont. http://www.uvm.edu/~tpswww/.

¹⁷ "Bike Sharing Program at UVM." 2012.Web. University of Vermont. http://www.uvm.edu/sustain/node/1190>.

¹⁸ "About Yale University." 2014.Web. < http://www.yale.edu/about/history.html>.

¹⁹ "Yale Bikeshare." 2014.Web. <http://to.yale.edu/yale-bikeshare>.

In 2004, "Rides Across Dartmouth" attempted again to provide lockless bikes to students under a \$1000 budget. These bikes were bought from Wal-Mart and maintenance and accountability issues once again prevented longevity in the program.

In 2006, accountability under a pay-per-lock system was implemented. 100 bikes were purchased and each participant paid \$10 for a key that opened all of the locks. These bikes were more expensive than past systems, and a waiver signed by participants held those involved accountable for the bikes. However, the bikes were once again lost or damaged within a few weeks and the program was shut down.

A business plan for a bike share plan was proposed in 2012 by the Sustainability Office interns which included a more advanced system of tracking users of the bikes through an ID card. Through a program "Bike-by-Bike Giving" they projected an estimated up-front cost of \$200,000 and based on membership and per ride pricing estimated \$110,000 in revenue per year. Yet, the maintenance for their 60 proposed bikes would amount to \$96,000. This plan recommended the next steps of identifying funding sources, performing studies on designs and feasibility for station locations, and finally construction and implementation.²⁰

How it Works

Bike Share

The bike share program will be based on a membership program. Participants will register online and can buy memberships for 24 hours, 3 days, a term, or a year. Once a member, participants can unlock a bicycle online or by inputting their account number and pin code on the keypad located on the bicycle. Participants can then ride the bicycle to their destination and drop it off at their nearest bike hub or at any bike rack within Dartmouth College's campus. Users are held accountable for a bicycle up until the moment that they return it to a bike rack. The bike share program uses software that allows Dartmouth College to track bicycle usage, thus ensuring accountability. The program would run year round, except during the winter term. During the winter, the bikes would be stored in an existing bike storage room.

²⁰ "Bike Share Business Plan 2012" Kier, Laura, and Benjamn Hughey. Dartmouth College: Office of Sustainability, June 2012

Social Bicycles (SoBi)

The specific bike share provider that we have chosen to work with is Social Bicycles (SoBi). SoBi is different from other bike share providers because they have integrated the bike share technology into the bicycle itself, rather than on a bike rack or kiosk.

The bicycles have an integrated lock that is unlocked by a smartcard or through the keypad attached to the back of the bicycle. Bicycles can be reserved online on through the SoBi smart phone app. Once a bicycle is reserved, you have 15 minutes to unlock it or else the reservation will be cancelled. Students can also unlock a bicycle by simply entering your account number and 4-digit pin number on the attached keypad. The recorded "ride time" begins once the bicycle is unlocked and ends once you lock the bicycle to a bike rack. Cyclists are allowed to ride the bicycles as far as necessary, but they must be returned to any bike rack on Dartmouth's main campus or to one of the bike racks that have been specifically designated for the SoBi program. A bicycle must be returned to campus within 24 hours or a fee will be charged to the last person to check out the bicycle.

SoBi is different than other bike share providers because the bicycles also have an integrated GPS that allows riders to return their bicycles to any bike rack (within Dartmouth Campus) and not just the established bike hubs. Users can then use the SoBi website or mobile app to track where the nearest bicycle is located. This feature is especially helpful for Dartmouth because walking back and forth between bike hubs can sometimes take longer than simply walking to the destination. The GPS also acts as a theft deterrent because the location of the bicycle can be tracked at all times. Usage data collected by the GPS also allows for the integration of a rewards or incentive program to encourage bicycle usage.²¹



Social Bicycles smart bike

²¹ Social Bicycles Customer Overview. Social Bicycles, 2014. Print.

Budget

The bike share by Social Bikes is more cost-effective than other bike shares. We have come up with a modest (in terms of cost and size) bike share plan.

Preliminary surveying of students on their biking habits and potential biking locations has determined that the bike share program should have 6 bike rack locations with 10 bikes each. Ideal locations would include The Hopkins Center, Life Sciences Center, Baker/Berry, Thayer School of Engineering, Collis, and the Dartmouth Coop.²² Upon approval of the bike share program, a more in depth study will be conducted to determine if any locations need to be changed or added. The bike racks are not permanently fixed, so they can be moved if it is later determined that there are more ideal locations on campus.

Costs

Initial Costs \$10,000 feasibility study and installation plan \$1,550 per smart bike (includes bike rack) Total Initial Cost = \$93,000

(Optional Items)

\$10,250 Freestanding Payment Kiosk\$2,250 Freestanding Info/Map Panel\$2,000 Indoor Tablet

Operating Costs

\$240 Smart Bike Connectivity Fee (per bike per year)
\$75 estimated replacement parts (per bike per year)
\$6480 Bike Share management intern salaries
Total Annual Operating Costs = \$25,380²³

²² ENVS 50 Class. "Bike Share." Survey. April 2014.

²³ Social Bicycles Pricing Overview. Social Bicycles, 2014. Print.

Revenue

Secure financial backing will be key for the implementation of the bike share. We have divided our costs into initial and operating costs and laid out potential funding sources for each.

Initial Cost Funding Options

Dartmouth College

The school itself could potentially pay for the capital cost of the program either through the college endowment, student assembly investments, or the Green Revolving Fund, a fund that supports Dartmouth community projects.²⁴

Alumni

Students could reach out to alumni through various mediums (phone calls, emails, at oncampus gatherings) to encourage bikes as gifts from alumni. Incentives for donation could possibly include the name of the alumni on a bike, rack, or a plaque somewhere on campus.

Students

There are multiple options for student fundraising at Dartmouth for the implementation of the bike share. We could potentially set up a system through which students can donate money via their DASH accounts. Additionally, a campus-wide fundraising event co-sponsored by the Dartmouth Biking Club and the Sustainability Office can be put into place. A fundraiser of this sort would not only target students, but Hanover residents and local businesses as well. An online crowdsourcing fundraiser, through a website like Kickstarter, could also be created in order to allow anonymous donations. This method has proven to be successful in the past. For example, the Dartmouth student-run business "The Box" was able to fundraise enough to meet their initial costs through online donations and are now up and running. A similar method could prove to be beneficial for our proposed bike share program.

Advertising

Local businesses could potentially buy advertisements located on the bikes themselves.

²⁴ "Green Revolving Funds: An Introductory Guide to Implementation & Management" Indvik, Joe, Rob Foley, and Mark Orlowski. *Sustainable Endowments Institute & the Association for the Advancement of Sustainability in Higher Education*, Jan. 2013. Web. 21 May 2014.

Operating Cost Funding

The SoBi bike share program would require an annual budget of approximately \$25,380 per year in order to operate. We believe that the program itself can easily generate this money. The bike share will bring in yearly revenue that is dependent on the success of the program. The following revenue estimate is based on what is needed in order for the bike share program to be self-sustaining. Yearly revenue of \$27,250 can be achieved by selling 100 yearly, 750 termly (250 each fall, winter, and spring), and 100 three-day passes at the following prices:

Membership	Price
24-hour	\$5
3-day	\$10
Academic Term	\$25
Annual	\$75
Daily Free Time	60 minutes

Daily free fille	00 minutes
Overage Fee	\$3/hour
24-hour non-return fee	\$10

Each membership gives users 60 daily minutes to use during their rides. A ride begins when the bicycle is unlocked and ends when the bicycle is locked at a bike rack. Upon using up the allotted 60 minutes, users will be charged \$3 for every subsequent hour. This is to prevent the bike share from becoming a bike rental program, where users take bikes for days at a time.

The Market

The bike share by Social Bikes has the potential to make much more than the yearly operating costs. The purpose of this bike share is to facilitate transportation within Dartmouth College and trips to surrounding establishments. We seek not to replace other operating bicycles at Dartmouth, but to instead provide casual cyclists with a reliable bicycle that they can use for short trips. This means that our target markets are the following:

- 4,200 Undergraduate Students
- · 2,000 Graduate Students

Undergraduate and graduate students would purchase the majority of the term-long and annual memberships, while college visitors would purchase the bulk of the daily and 3-day passes. This means that the program can potentially earn much more than what is necessary for it to be self-sustaining. The extra annual revenue can be reinvested into other sustainability programs.

Expected participation is difficult to accurately measure without a long-term feasibility study. Although the preliminary survey indicates there are a large number of willing participants, there may be discrepancies between the willingness to participate when taking an anonymous survey and actually signing up for a membership. Yet, due to the number of memberships needed to cover the yearly operating costs, we are optimistic that implementing this system would increase cycling on campus and contribute to becoming a "bike-friendly" campus.

We expect this bike share program to appeal to all students and anyone visiting the Dartmouth campus, but our system will specifically be aimed at appealing to more casual cyclists. SoBi isn't meant to replace all bicycles on campus, but rather supplement them and help reduce the number of bicycles that are left behind. Every year about 120 bikes get abandoned around Dartmouth College. Bicycles are usually abandoned by students who are unaware of all the care that goes into maintaining a bike at Dartmouth College. These students only need the bicycle a few times a week, so once maintaining and storing it becomes too much of the hassle then they'll be tempted to simply abandon it. SoBi would allow these casual users to sample out a bicycle before they commit to buying one for themselves.

Another group of students that would greatly benefit from this program are those who want a reliable bicycle but don't want to spend hundreds of dollars on one. Because of financial constraints, this demographic often buys cheap and unreliable bicycles that break easily and are abandoned as a means of disposal. SoBi's smart bikes are made from rust and corrosion resistant aluminum frames with stainless steel components and puncture resistant Kevlar tires. The cheap and unreliable bicycles may not make it through the year, thus costing more than the price of an annual pass to the bike share program.

Another potential target group would consist of graduate students from Tuck, Thayer, or the Medical school who do not own cars or find it inconvenient to drive their car into town. These individuals could simply take a bicycle from one of the bike racks in their area and ride it into town. Doing so would save them money on parking and gas while at the same time reducing carbon emissions.

Lastly, our target demographic includes the ~50,000 annual visitors to Dartmouth. Parents, friends, and alumni who visit Dartmouth could use bikes for transportation around campus as well as for scenic rides of the beauty that New Hampshire has to offer. The majority of the time, visitors come to Dartmouth on the Dartmouth Coach, so their only source of transportation would be the SoBi bicycles.

Why It Will Work

Accountability

After examining past programs, it has become clear that the biggest issue with a bike share program at Dartmouth is accountability. SoBi completely takes care of this issue through its integrated data collection system. Participants will be given an account number and pin code upon registering for the program. The system keeps a record of the times and names of the people who have used each bicycle. This data is sent to the system administrator of the bike share program at Dartmouth and the administrator could then contact the last person to use a bicycle if it is damaged or goes missing. Another feature of SoBi is the use of a GPS that is built in directly into the bicycle. The GPS is built into the keypad that is powered by a battery. The battery is solar and rider powered, which allows for the bike to be located regardless of its location. The location of every bicycle is also sent to the system administrator, which would allow for the retrieval of a bicycle if it were to be left somewhere outside of the Dartmouth area. We believe that these two features would solve the issue of accountability, thus allowing for a successful bike share program at Dartmouth.



Social Bicycles Online App

Management

In order to ensure that the bike share program runs smoothly at Dartmouth, we propose to have two management interns, working closely with the Sustainability department, to oversee the program in addition to four or five bike runners, who redistribute the bikes to the six campus hubs. This management program would not only increase the number of on-campus job opportunities, but also give students the experience of running their own small business. The job descriptions of these positions are as follows:

Bike Share Manager

This individual is responsible for the general management of the bike share program. He or she would keep track of every participant, both long and short-term members, monitor the location of each bicycle, and contact the last student responsible for any damaged or missing bikes. This individual would act as a connection between the Dartmouth bike share and Social Bicycles; he or she would also be the main contact for costumers with comments or complaints. Additionally, this intern would supervise the bike runners, assigning them locations to return the bikes to. This intern would work approximately 6 hours per week earning \$10/hr.

Bike Share Treasurer

This intern would be in charge of budget and revenue management of the bike share system. He or she would work directly alongside the bike share manager, completing similar tasks but focusing more on expenses and possible sources of revenue. This intern would work approximately 6 hours per week earning \$10/hr.

Bike Runners

The bike share program would also employ four or five bike runners. These students would be responsible for retrieving and redistributing the bicycles evenly at the six bike hubs throughout campus three times per week. These students would each work approximately 3 hours per week earning \$8/hr.

Possible challenges of implementation

Bike shares come with numerous challenges such as cost, placement, usage and safety. In order to tackle these issues, our class must be able to find a source of funding for high upfront costs, map out qualified places for the bike racks, ensure the availability to riders and promote safe riding practices.

Placement of the bike racks needs to be strategically planned out to maximize usage of the bikes for visitors (and others who do not have an annual/term pass). Our survey has given us a number of hotspots that students would frequently bike to and from. Yet, more research is needed to figure out where campus visitors would most likely want to bike.

Bike safety is also a concern after implementation. To decrease the likelihood of a crash, registration with the term long pass could possibly include a biking education class. However, for visitors and daily pass riders safety is still an issue. As possible solution to this problem, we could start a helmet rental system in Collis or from a student organization such as the Dartmouth Outing Club.

Commuters

Background

Faculty, staff, and graduate students make up 60% percent of the Dartmouth community,²⁵ and it is important that we address their biking needs too in addition to student needs. There are tangible cost, fitness, time, and safety benefits to bike commuting that Dartmouth should work to encourage. One study found that "if American drivers were to make just one four-mile round trip each week with a bicycle instead of a car, they would save nearly 2 billion gallons of gas. At \$4 per gallon, total savings would be \$7.3 billion a year."²⁶ Based on Dartmouth's 2009 Parking and Commuting Survey (the most recent survey of this kind) 67.8% of employees drive to work regularly and fill over 2,600 parking spots. 90% of graduate students and 40% of faculty and staff live within 5 miles of Hanover Green²⁷, yet many of these people drive to campus regardless. Table 4 illustrates the commuting distances of faculty, staff, and graduate students:

Miles	Students		Faculty/ staff		Cumulative Total	
	#	%	#	%	Total	%
0-1 miles	877	45.4%	397	9.5%	1,274	20.8%
0.00-0.50	673	34.8%	252	6.0%	925	15.1%
0.51-1.00	204	10.6%	145	3.5%	349	5.7%
1-5 miles	865	44.7%	1,286	30.8%	2,151	35.2%
1.01-2.00	426	22.0%	409	9.8%	835	13.7%
2.01-5.00	439	22.7%	877	21.0%	1,316	21.5%
5+ Miles	191	9.9%	2,496	59.7%	2687	44.0%
Total	1,933	The Los	4,179		6,112	

Commuting distances to Dartmouth (Dartmouth College Parking and Commuter Survey, 2009)

Driving to campus leaves campus congested, creates air pollution, and can often take more time than alternative modes of commute. In fact, half of the working population in the United States commutes five miles or less to work, with bike trips of three to five miles taking less time or the

²⁵ Dartmouth College Parking and Commuter Survey, 2009.

²⁶ Hendriksen, I.J.M. 2010.

²⁷ Dartmouth College Parking and Commuter Survey, 2009.

same amount of time as commuting by car.²⁸ We propose various incentives and new policies at Dartmouth to encourage cycling as a form of commuting to and from campus. As current commuters have demonstrated, bike riding can be a viable alternative to driving and is good for both physical and environmental health. It is also cost-effective in many ways: bikers who ride to work are associated with less sickness absence, and the longer distance they travel regularly, the less they report sick.²⁹ Bike commuting would also save the College a substantial amount of money, as it would diminish the need to construct additional parking spaces for commuters. According to a Transportation Demand Management (TDM) report from the Dartmouth Office of Planning:

It is reasonable to assume that with improved conditions for bicycling, the percentage of bicycle commuters could increase by 400%. This would translate into an additional 62 solo drivers shifting to the bicycle, yielding an additional 30 cars taken off the road on a regular basis. This would save Dartmouth \$750,000 for parking spaces they would not need to develop.³⁰

From the 2009 Parking and Commuting Survey, 32.4% of 1,610 on-campus employees surveyed (faculty and staff) and 46.9% of 557 graduate students said they planned on walking or biking to campus more often.³¹

We have conducted 25-30 interviews, taking a random sample of current cyclists, potential cyclists, and motorists to better evaluate commuter needs and preferences. This section will focus on the Encouragement angle of bicycle commuting through three main avenues: a more permanent Bike Repair Shop on campus, a health incentive tied to the Dartmouth Wellness Initiative, and social incentives framed in the context of bike-related events and programs geared directly towards commuters.

Target Demographic

First, we must address the fact that there is no "typical" bike commuter at Dartmouth. According to Hanover's 2012 Pedestrian and Bicycle Master Plan, there are four main demographics of cyclists. Of the faculty and graduate student population we interviewed,

²⁸ Woodruff, 2014.

²⁹ Hendriksen, I.J.M. 2010

³⁰ Dartmouth College TDM Strategies, March 2013. BFJ Planning, 2013.

³¹ Dartmouth College Parking and Commuter Survey, 2009.

approximately 15% of people fit into the Strong and Fearless label, 40% fit into Enthused and Confident, 30% were Interested but Concerned, and 15% fell into No Way No How.³²



Breakdown of target demographic, from the Hanover Pedestrian and Bicycle Master Plan, 2012.

Both the Strong and Fearless and Enthused and Confident groups tended to commute via bicycle regardless of any Encouragement programs put forth by Dartmouth. It still was helpful to interview these people to better understand what would make their commutes easier and potentially foster a stronger bike commuter community at Dartmouth. However, we want to focus more of our efforts of Encouragement on the Interested but Concerned group that is unsure about cycling as a form of commuting but would try it out, given the proper conditions and motivations.

Barriers to Bike Commuting

The commuter interviews demonstrated trends in what were perceived to be barriers to bicycling at Dartmouth. The most common obstacles cited were:

- Safety
- Weather
- Maintenance and storage during the day
- Commuting distance and terrain (hills)

³² Bike Commuter Personal Interview Data, April-May 2014.

Other commitments that necessitate a car (children, commitments outside of Hanover, late working hours)

While some of these challenges are unable to be solved by new policies, many can be addressed through Encouragement programs that provide tangible and intangible incentives for people to commute to Dartmouth via bike. Many bikers and non-bikers would agree that "facilities on campus are really atrocious for bicycles,"³³ and that there is much to be done not only to change physical bike infrastructure that the Engineering section will discuss later (lanes, paths, etc.), but also much that can be done to improve social perceptions surrounding cycling. Bike safety is one of the first and foremost concerns of cyclists and non-cyclists. Ensuring a safe biking climate requires the work of Engineering to develop infrastructure and Education to develop resources about road safety, but it also relies on Encouragement to change the way that bikers and non-bikers interact with one another. Many bikers around campus do not obey proper traffic rules (including riding on sidewalks or riding the wrong way on streets), which many feel "fosters a culture of mistrust if students or staff start acting like pedestrians on their bikes."³⁴ Interviewees who lived close by but chose not to bike commute cited safety between motorists and bicycles as the primary reason that they chose not to bike. One opinion maintained that:

Cars do not share the road respectfully, the bike lane gets impossibly narrow under the underpass, and cars rush to make the right turn onto the highway (in the westerly direction), crossing the bike lane (it's scary for pedestrians as well!). Drivers honk and even heckle when they pull up to you, as if you are an annovance and obstruction, and it's just unnerving. I arrive flustered and feeling not relaxed when I bike.35

Based upon commuter interviews, it seems that non-cyclists perceive motorists as dangerous, while cyclists tend to criticize the behavior of fellow cyclists on the road. Some commuters said that cyclists would ride the wrong way on roads or ride between cars and not act like real vehicles. At the same time, however, not all drivers obey speed limits, stay between the lines on the road, or stop at stop signs and red lights, which proves a hazard for bikers, pedestrians, and other motorists.9 Both sides should be encouraged and educated about road safety and should

 ³³ C. Sullivan, personal interview, April 13, 2014.
 ³⁴ J. Collier, personal interview, April 22, 2014.

³⁵ I. Schweitzer, personal interview, April 24, 2014.
participate in programs that facilitate better communication and understanding between these group. Bikers should learn to ride defensively, which means "protecting your place on the road and getting drivers to slow down and pay attention"³⁶ and motorists should break free of their assumptions that they are the only vehicles allowed on the road. Motorists should learn about the good things bikers bring to the community, so that they can shift from a position where cyclists feel threatened to one where they feel respected and accommodated.³⁷

At the same time, bikers should take courses in road safety and regulation because "we can't have a growing culture of acceptance of bicycles if the bikers are making up their own rules."³⁸ The League of American Bicyclists offered specific classes on topics such as Bike Skills 123, Traffic Skills, Group Riding, and Commuting,³⁹ and Dartmouth should look into partnering with the Physical Education, Health Services, or local bike shops such as the Bike Hub or Omer & Bob's to offer classes similar in structure to bikers and motorists. In addition to teaching about road safety, these courses could be offered in conjunction with Wellness Workshops (discussed later in this chapter) that educate people and overcome the hesitations people might have about where to buy a bike, what equipment is necessary, where to shower and park, and what commuter benefits are available to cyclists. The workshop could happen immediately to make people aware of what resources are currently available (such as the Opt-Out program), and then follow-up curricula could be created to introduce new benefits and services as they roll out.

Current Bike Commuter Programs at Dartmouth

Dartmouth already offers a few benefit programs for commuters to encourage bike riding, and the surveyed sample provided mixed feedback on these programs, ranging from some who cycle because of the benefits, to others who are unaware or unaffected by the benefits and incentives. One program currently in effect is the Opt-Out Program, which has 183 participants.⁴⁰ This program provides a free shower pass at Alumni gym for cyclists, an emergency ride home program that provides reimbursement up to \$50, and four free parking passes per month for those that do not bring a car to campus.⁴¹

³⁶ R. Howarth, personal interview, April 14, 2014.

³⁷ J. Wilson, personal interview, April 14, 2014.

³⁸ C. Sullivan, personal interview, April 13, 2014.

³⁹ "Take a Bike Class." League of American Bicyclists Website. 2014. Web. April 2014.

⁴⁰ Dartmouth College Parking and Commuter Survey, 2009.

⁴¹ Dartmouth Green Commute Website

One complaint that many cyclists and non-cyclists had about the current system concerns the Shower Pass component of the current Opt-Out system. While the College advertises its free Shower Pass program to some extent, the reality is that anyone with a Dartmouth ID is able to enter the shower facilities. The problem arises because no free lockers are available for bicycle commuters specifically, so they must carry their dirty clothes and wet towels into their offices, which is a major deterrent for commuters. An incentive that provides a space to store bike attire in addition to the shower service is likely to have a positive impact. Others are dissuaded by how far away the gym is from many buildings on campus. Dave Lutz from Environmental Studies commented:

One thing that would dramatically change my situation would be if there were showers available in my building that I could use to rinse off after riding in. When I am writing a manuscript, I need to be in the right frame of mind, and it is easy to be removed from that if I am bothered in any way...A shower would help immensely to reset my mind.⁴²

Some cyclists in the Thayer School of Engineering and Sudikoff buildings take advantage of showers within their buildings that allow them to commute more easily. Scot Drysdale, an avid bike commuter, suggests one of the most important improvements the College can make for current cyclists as well as potential new ones involves more accessible showers for those who choose to bike as a form of fitness.⁴³ Amy Newcomb of the Dickey Center added that if it weren't for the shower in Haldeman, she would not choose to commute.⁴⁴ Dartmouth should investigate a way to improve access to shower facilities in all main areas of campus and make these locations known to commuters.

About one-half of bike commuters interviewed were aware of the Opt-Out Program and approximately one-third actually took advantage of some of its benefits⁴⁵. However, commuters had specific complaints about the number of parking passes offered per month--especially in the colder, darker months--and said that four simply was not enough to account for sick days and emergency days when a car would be needed. One avid cyclist suggested being able to purchase individual parking passes instead of the four allocated passes per month, because then they can

⁴² D. Lutz, personal interview, May 3, 2014.

⁴³ S. Drysdale, personal interview, April 16. 2014.

⁴⁴ A. Newcomb, personal interview, April 30, 2014.

⁴⁵ Bike Commuter Personal Interview Data, April-May 2014.

be used at the rider's discretion.⁴⁶ If a coupon system for 5 or 10 rides were available and translatable into a certain number of free parking passes, or alternatively if a monthly permit were available people might be more inclined to give up their regular permits and bike more, knowing that they still had more freedom when it came to driving in rare instances. A coupon system for a certain number of rides would eliminate the hassle of commuters needing to go to the parking office each time they wanted a daily pass, and would also let them keep track of the number of times they have used alternative modes of transportation to get to campus. We propose using the Zap Box program as a system of tracking rides.⁴⁷ This ability to track the number of rides will be coupled with an incentive program that will offer rewards to commuters for biking, some of which include additional parking passes.

⁴⁶ R. Howarth, personal interview, April 14, 2014.

⁴⁷ Dero Zap Commuter Website. http://www.dero.com/products/zap/zap-description.html

Zap Box Commuter Incentive Program

It may be useful to have a commuter incentive program to encourage biking and safe behaviors. The program is designed to add benefits to biking to work so that the opportunity cost of driving is high for those living near enough to campus to comfortably bike. Unlike the student bike share and corresponding incentive program, there is currently no electronic way of logging rides for commuters. Therefore, a passive and effortless recording system is necessary.

We propose to use Zap boxes by Dero,⁴⁸ which is used successfully in many other locations, most notably the University of Minnesota and its surrounding community. It is worth



Solar-powered Zap box mounted on a pole

nothing that while it has been successful in that region, the Dartmouth and Hanover community is much smaller and it is therefore important for another party to consider the impact this program would have. These Zap boxes are solar-powered metal transmitters that can be easily attached to a pole or building and require no wiring or maintenance. Registered bikes will have a small tag placed on their front wheel spokes, and as cyclists pass a Zap box, they will get

⁴⁸ Dero Zap Commuter Website, 2014. < http://www.dero.com/products/zap/zap-description.html>

"zapped," i.e. their ride will be logged onto the electronic system. Using this electronic log, appropriate rewards will be given to those commuters who ride most often. The following table outlines an example rewards system for commuters:

Logged Rides Per Month	Reward
1	Free hot or cold drinks (season-appropriate) twice a month
5	Coupon to local business of the month (as part of the Bicycle Benefits program, ⁴⁹ see page 51)
10	Additional individual free parking passes
10 for 3 consecutive months	Voucher for Dartmouth Biking apparel and gear

Since the Zap boxes will only be used to log commuter rides, we only propose to purchase three boxes and place them at the three entrances to campus: Wheelock St. and North Main St., Wheelock St. and College St., and Park St. and College St.

The boxes are a justifiable price if the college is invested in increasing and encouraging biking amongst faculty, staff, and graduate students. Each logging box costs \$5000, but requires no extra maintenance or wiring costs. Each bike tag is \$3.60, so we suggest buying 100 tags to launch the program.⁵⁰ In total, the infrastructural cost of this proposed Zap incentive program is estimated at \$1,860 with only nominal costs per rider if the program would like to expand and purchase more bike tags. The cost of the rewards system is variable based on the amount of participants and their dedication to bike. The rewards system will require minimal oversight, simply oversight of the ridership database.

This incentive system has been very successful at other institutions and cities. The University of Minnesota experienced a 40% increase in bike commuting between 2009 and 2012, which they accredit to this incentive program and their University Bike Center.⁵¹

While financial disincentives (expensive parking passes) may motivate some to drive less, we do not propose penalizing people who need to drive to work out of necessity. The

⁴⁹ Bicycle Benefits Website, 2014.

⁵⁰ S. Sanders, personal interview, April 14, 2014.

⁵¹ S. Sanders, personal interview, April 14, 2014.

housing and real estate market affords employees who make the most money to live closest to Hanover, and these people with higher salaries may not be dissuaded from driving even if parking fees increased. This would disproportionately affect those who live further from campus who need to drive to campus. Feedback from the 2009 Survey suggested that people who drive from closer distances should be charged more because it is more realistic that they would have alternative modes of commuting, and many felt that "Dartmouth needs to show more respect to the fact that the majority of non-faculty cannot afford to live within walking/biking distance. Commuting is a necessity for most of us if we are to afford a decent housing situation. Therefore parking is a necessity, not a luxury to be squeezed out by new buildings and fees"⁵². A case study of potential solutions comes from Professor David Plunkett of the Philosophy department, who lives in Thetford, too far away to bike to work. His biggest suggestion was that the College do a better job providing faculty short-term housing in Hanover, which would in turn cut down on commuting. He noted that the College wants faculty to live close by to facilitate more interaction with students, but that it is hard for new or younger faculty who do not make as much money to do so.⁵³ For this reason of income disparities among Dartmouth employees, we hope to modify existing parking programs instead of using more financial disincentives. Parking will be discussed further in the following chapter of this paper.

⁵² Dartmouth College Parking and Commuter Survey, 2009.

⁵³ D. Plunkett, personal interview, May 2, 2014.

Better Bike Facilities: Covered Bike Racks and Self-Service Stations

Covered bike racks and better bike parking in general are additional infrastructural changes that commuters strongly advocated for. Almost all respondents pointed to the covered bike racks by the Life Sciences Center as a model for what bike parking should be on campus. Both Enthused and Confident riders and Interested but Concerned riders felt that covered racks would encourage more faculty, staff, and graduate students to commute. The Engineering chapter will discuss how changes in bike parking will also target undergraduate students who ride around campus.

Bike commuters often have more regard for how their bike is treated because they depend on it for longer distances than undergraduate students, which is one explanation for the overwhelming demand for covered bike racks. In addition to improving bike parking, cyclists suggested better maintenance tools and services on campus, especially because there is no bike repair store in town. One possibility is to combine basic maintenance tools with new covered bike racks—for instance having self-service stations at some of the bicycle parking facilities. DERO's Fixit model is a popular maintenance and repair station at many Bike Friendly Universities,⁵⁴ and we suggest that Dartmouth invest in this or a similar system to make it easier for both students and commuters to perform basic bicycle repairs. The Engineering section will further discuss these ideas in the final chapter of this document.

^{54 &}quot;Fixit." Dero.com. Web. May 2014. < http://www.dero.com/products/fixit/>

The Dartmouth Bike Repair Shop

Right now, Dartmouth Bikes, an initiative of the Sustainability Office, is responsible for holding Pop-Up Bike Shops (PUBS) throughout the term. The goals of the program are to increase ease of bike use, decrease bike waste (including bikes that get abandoned), and support a bike culture. While Dartmouth Bikes is still in its testing phases, there are some immediate changes that should be made. Currently, the pop-up bike shops are strongly catered to undergraduates, and many graduate students we interviewed were unaware the pop-up clinics existed, found out too late, or felt that the hours were inconvenient. To better accommodate the schedules of both faculty and graduate students, we propose a more permanent Bike Repair Shop (see page 144 for reference) on campus that could be run out of the space in Fahey basement that the Sustainability Office currently occupies for Dartmouth Bikes. The regularity in hours would allow commuters as well as students to benefit. Further details of the Repair Shop will be discussed in the Engineering chapter of this report, under the Bike Maintenance section.

Hugh Mellert, a seasonal bike commuter and a member of the Hanover Bicycle and Pedestrian Committee, strongly advocated for a permanent place on campus where people could get advice and guidance about bike ownership as well as get repairs and tune-ups.⁵⁵ Interviewees noted that the Bike Repair Shop would serve non-avid cyclists who struggle with finding a place for bike maintenance, and easy availability to tools and services would be attractive to people who already commute. According to Professor Richard Howarth, Strong and Fearless bikers typically know how to do their own basic repairs, including fixing flats, keeping brakes and derailleurs adjusted, and keeping the drive train clean and lubricated, but they still might find a specialist helpful for other types of repairs.⁵⁶ The Repair Shop would not only provide labor but also basic tools and equipment (chains, tubes) that cyclists could purchase to work on their bikes themselves if they so choose. As the Engineering section will discuss, self-service repair stands with tools and air pumps at various short-term parking locations would also be beneficial to commuters and students and will be a project overseen by the Repair Shop (see page 149 for details).

We have also talked with the Sustainability Office about some kind of vending program that could be outsourced to one of the local bike shops and sell supplies from them directly,

⁵⁵ H. Mellert, personal interview, May 2, 2014.

⁵⁶ R. Howarth, personal interview, April 14, 2014.

which would give the Bike Repair Clinic an opportunity to market their services as well as inform new cyclists of what types of biking services and products are available nearby. As one Ph.D. candidate who commutes via bike explained, "people who don't have bikes are daunted by the bike-ownership responsibility."⁵⁷ However, a more permanent Bike Repair Shop could prove how simple and accessible bike maintenance can be for any level cyclist. A permanent shop, more so than the pop-up bike shops that currently exist, would be able to reach wider audiences of cyclists and potential cyclists, and break the stereotype that having a bike is too great a responsibility for the average commuter.

Many commuters explained that it is easy to neglect bike maintenance needs because of the hassle that bringing a bike to a tune-up shop requires. The two major bike shops in Norwich and Lebanon are too far out of the way for most commuters to get to during the workday, and most interviewees wished a bike store still existed in Hanover. The process of attaching a bike rack to your car and driving to have your bike repaired is a strong disincentive for people intimidated by bike maintenance. A permanent Bike Repair Shop on campus would allow cyclists to ride their bike in the morning, leave it at the Repair Shop for a few hours during the day, and have it returned by the afternoon to ride home.

Commuters responded positively to the idea of free tune-up services as an incentive that would encourage them to ride more and they also felt it might help attract new cyclists by motivating them with the promise of rewards and services. We feel that the Repair Shop would be an essential resource and draw for commuters since all labor costs of the Repair Shop would be free for anyone with a Dartmouth ID. The Repair Shop could work with our second proposed solution, the Health and Wellness incentive, which will further publicize the benefits of and services offered from bike commuting at Dartmouth.

⁵⁷ J. Bradley-Cook, personal interview, April 8, 2014.

Health and Wellness Incentives

The Wellness at Dartmouth initiative should partner with the proposed Repair Clinic to better market bike services on campus and educate commuters as to why cycling is good for physical and mental health. Countless studies and firsthand examples point to the health benefits of biking to stay active, and we propose that Dartmouth use this as motivation to promote biking among its employee and student commuters. On average, bike commuters lose 13 pounds in the first year of cycling alone when it becomes a regular habit⁵⁸. Wellness at Dartmouth focuses heavily on preventative health service and programs that try to shift the culture surrounding employee health,⁵⁹ and biking has the potential to meet both physical and mental health needs of Dartmouth commuters. As Rosi Kerr of the Sustainability Office commented, "I feel personally incentivized by the benefits of biking. I'm much happier when I bike to work. It gets me in the right mindset for the day."⁶⁰

⁵⁸ Woodruff. 2014.

⁵⁹ Wellness at Dartmouth Website. 2014.

⁶⁰ R. Kerr, personal interview, April 29, 2014.

Ideas for a Reimbursement Program

35% of bike and non-bike commuters interviewed were in favor of some kind of healthinspired incentive program that would reward people for bike commuting on a regular basis.⁶¹ Currently, Wellness at Dartmouth has a subsidy program with the fitness classes at Alumni Gym and other fitness centers where it reimburses employees up to \$200 for participating in a fitness activity for the term.⁶² It is a way to encourage employees to stay active, which benefits the College in terms of employee attendance, working culture and overall well-being. Participants keep track of their fitness class attendance on a card that they have signed each week by the fitness center, and most feedback of the program has been positive. Many faculty and graduate students we interviewed were aware of the Fitness Reimbursement Program⁶³, and wondered if there was a way for similar benefits to be passed on to bike commuters.

There are several potential ways that Wellness at Dartmouth could be involved in incentivizing biking. It should begin with promotional education workshops and programs that give new cyclists an idea of where to purchase bike equipment, how to bike safely, and inform them of the health benefits of biking instead of driving to work. Next, it might offset a portion of the initial costs involved in purchasing or maintaining a bike and provide reimbursement for people who commit to riding a certain number of days per month, measured with the Zap box program.

⁶¹ Bike Commuter Personal Interview Data, April-May 2014.

⁶² "Fitness Reimbursement Benefit. Wellness at Dartmouth Website. 2014. Web. April 2014.

⁶³ "Fitness Reimbursement Program. Wellness at Dartmouth Website. 2014.

Insurance Discounts for Cyclists

In addition to direct financial incentives like reimbursements and material incentives like repairs and equipment services, we propose that Wellness at Dartmouth and Dartmouth College Health Services provide insurance reductions for bike commuters as a way to keep current commuters cycling as well as draw in new potential bikers. Jack Wilson, a professor in the Thayer School of Engineering, bikes or walks to work from his home in Hanover when he can. At the mention of a health-focused incentive, Wilson added, "if you bike and can document it, then maybe an incentive like a reduction in health insurance costs, like those when employees use the gym, could help you to be healthy. I think lower insurance costs would be attractive to many people."⁶⁴ A similar program might be used to target the current graduate students who bike commute and would benefit from incentives, as they are on a different (student) health insurance plan than College employees.

⁶⁴ J. Wilson, personal interview, April 14, 2014.

Partnering with Wellness Workshops

Melissa Miner, Director of Health Promotion and Wellness at Dartmouth, is very receptive to expanding biking resources as a form of health and wellness on campus provided that additional research is done to support the program's implementation. Wellness at Dartmouth currently hosts Wellness Workshops that focus on a health-related topics ranging from stress and mindfulness to weight management and healthy eating. Workshops are advertised to the faculty, staff, and community so that everyone has a chance to participate. We asked Ms. Miner about putting together a workshop focusing on biking, and she agreed that even if it were just an informative workshop, it could still tie in multiple aspects of biking: from health benefits to what type of bike to buy and road safety tips for new bike commuters. Ms. Miner was also intrigued by online resources such as calorie counters, weather, maps, and commuting tips on the Wellness website that "would be great content for the workshop, and for somebody who is looking to track trips around commuting."⁶⁵ Wellness at Dartmouth also said it would support using social media like Facebook to promote any sort of incentive or education program for commuters surrounding biking and its health and wellness benefits.

In addition to informational workshops, Wellness at Dartmouth was interested in further expanding on their MOVE IT Physical Activity Challenge, which creates teams of Dartmouth employees who track their physical activities and sign up to win prizes that include clothing and fitness equipment.⁶⁶ It is already possible to track cycling or walking to work under this program, but we propose an additional Physical Activity Challenge that emphasizes biking specifically and motivates people to bike to work more regularly.

There are still many areas to explore in getting Wellness at Dartmouth and Dartmouth College Health Services involved with a biking curriculum geared towards employees. We understand that Wellness at Dartmouth requested more research on this topic and specifically on the health benefits of cycling, the number of current cyclists, and the expected number of employees who would participate in Wellness-sponsored programs on campus. Closer evaluation on how best to improve physical resources such as showers, bike storage, and bike racks on Advanced Transit are just a few issues that should be investigated immediately. Specific information about what to subsidize in any of these subsidy programs (equipment, maintenance,

⁶⁵ M. Miner, personal interview, April 18, 2014.

⁶⁶ "MOVE It Challenge." Wellness at Dartmouth Website. 2014

etc.) and how much a full or partial subsidy would cost is also an important variable. This program is intended to further support commuters already committed to biking while at the same time trying to attract new bike commuters.

Social Incentives

There are various social and cultural incentives that can help bridge some of the gaps between existing cyclists and Interested but Concerned bikers. From our interviews with Dartmouth employees and graduate students, we found that many people would be interested in some sort of bike-themed event in order to educate and encourage a stronger bike community here. Interviewees discussed their past experiences in biking communities such as Santa Cruz CA, Berkeley CA, Madison WI, Seattle WA, and Chicago IL, and pointed to the fact that all of these places had bike-themed parties and social events that drew people of all biking backgrounds. Professor Charlie Sullivan felt that social events were good for people who wanted to be part of a movement and advocate for a bike culture, but did not necessarily want to attend town hall meetings.⁶⁷ Bike events also have the potential to target multiple demographics at once: undergraduates, graduate students, and Dartmouth employees, as opposed to the health incentive plan above that would need to be catered to each specific audience.

Many cyclists reflected on the obstacles they faced when they decided to start bike commuting, and iterated that the hardest part about it was doing it once and getting into the routine of biking. We propose events that build upon the existing Bike and Walk-to-Work day (which has limited turnout each year in Hanover), and try to encourage biking to work more than just one day out of the year. One suggestion is to target specific departments—for instance, the entire Mathematics department one week, then the Religion department another week—and invite them to bike in to the best of their ability, and provide free coffee or breakfast as a way for the department to talk about the benefits of biking and get over many stereotypes people have about the safety or practicality of it. College employees already have special benefits known as D-Perks that give them discounts from the Computer Store, Dartmouth Athletics, Hanover Country Club, and the Hood Museum of Art.⁶⁸ These D-Perks could be expanded to bring in rewards from other local services and vendors.

The College should issue coupons and gift cards initially as incentives for these biking to work programs, and build it into a benefits program modeled after Bicycle Benefits.⁶⁹ Bicycle Benefits is a nationwide program where cyclists purchase a \$5 sticker to put on their helmets to

⁶⁷ C. Sullivan, personal interview, April 13, 2014.

⁶⁸ "Additional Employee Benefits." Office of Human Resources at Dartmouth College Website. 2014.

⁶⁹ Bicycle Benefits Website. 2014.

signify they are part of the program. They then receive coupons at local businesses as a way to encourage members of the community to bike more often. The program currently operates in nearby places such as Burlington, Montpelier, Essex Junction, and Brattleboro, VT. It also has programs in Keene and Portsmouth, NH. We suggest Dartmouth and the Town of Hanover look into signing up with the Bicycle Benefits program to incentivize employees and students to receive benefits for biking. As part of the Zap Commuter Incentive Program mentioned above, commuters could receive free membership into the Bicycle Benefits program after completing a certain number of rides each month. The sticker on the helmet could then be issued for the following month, with a clear label or color to signify from which month the commuter is receiving rewards.

Bicycle Benefits differs from D-Perks in that it would cater to both graduate students and employees, instead of just Dartmouth employee commuters. Bicycle Benefits could host social gatherings regularly so that there is a social incentive to bike commuting. Environmental Studies Ph.D. candidate Marcus Welker suggested gathering a group of bike commuters on a Friday afternoon and treating them to free appetizers at Salt Hill Pub.⁷⁰ The tangible discount would serve as an initial incentive for participation among new cyclists, but the social ties could be what keep cyclists hooked into a community of bike commuters. Welker also suggested bike-themed scavenger hunts like the ones he attended in Anchorage, AK that are a fun way to meet people and celebrate biking. Dartmouth's Office of Human Resources could be in charge of championing various social events to build monetary, social and community incentives for biking. Social circles that would develop around a biking culture would be a great way for current and new cyclists to share stories and advice, and build relationships based on a common goal. This would further connect the entire Dartmouth community and give Dartmouth a better environmental, social, and health and wellness image.

⁷⁰ M. Welker, personal interview, April 18, 2014.

Biking Events and Bike Buddy System

Additional social events might include a bike parade or bike rally where some of the main streets in town or around campus could be closed to encourage biking. Many other towns and cities have a "Bike Boulevard" system that converts a main road to be for cyclists only. At these types of events, local vendors can come out and promote their products, and the College and Town could work together to provide free refreshments or small giveaways like reflectors, stickers, or clothing. The Hanover Bicycle and Pedestrian Committee's 2013 Bicycle Friendly Community Report suggested a Summer Streets event that would offer space to cyclists and pedestrians and encourage group exercise events.⁷¹ This program, if successful, could expand into the spring and fall seasons as well. The Committee also recommended social promotion rides each time a new bike-related project is completed, which would be an inclusive way of fostering a bike culture in Hanover and at Dartmouth College. Hugh Mellert articulated the role that Dartmouth plays in creating a local bike culture when said that "This is a college town, and so the issues around biking are going to be about the College as well. Any improvements in promoting cycling as a safe and effective activity, for both fitness and commuting, have to involve the College."⁷²

Some interviewees felt that the often solitary nature of biking deters many people from becoming cyclists. Typically, there are limited opportunities to interact with others when bike commuting, but a Park-and-Ride program might be something for the College to consider. This would be especially useful for the Interested but Concerned cyclists who feel that you get "safety in numbers." The College should map out common commuting routes from the main entrances to campus and distribute this information on its bike resources website under a section specifically for commuters. The 2009 Parking and Commuter Survey found that the most common commuting routes for employees were Ledyard Bridge from I-91 (38.4%), Route 120 from Lebanon (21.1%), Route 10 from Lyme (11.3%), and Route 10 from West Lebanon (11.5%)⁷³. Among graduate students, 23.2% used Ledyard Bridge, 23.2% used Route 10 from West Lebanon, 21.4% used Route 120, and 5.9% lived in Hanover.⁷⁴

⁷¹ Bicycle Friendly Community Feedback Report, Hanover, NH. Spring 2013.

⁷² H. Mellert, personal interview, May 2, 2014.

⁷³ Dartmouth College Parking and Commuter Survey, 2009.

⁷⁴ Ibid

Cyclists also supported a "Bike Buddy" system in which commuters could coordinate where to meet each other and ride in to work together, which would make the ride more enjoyable and feel safer for those that are intimidated by riding in alone. "Bike Buddies" could be eligible for certain rewards and might even be able to work with the Wellness incentives program to form teams to compete against other "Bike Buddies" or groups to see who can commute the most frequently or the furthest distance. Once commuters begin to see the feasibility and enjoyment that comes with biking, they might be encouraged to bike more recreationally in their spare time and get others to do the same. This trickle down effect, stemming from simple programs like buddy systems and small incentives, has the potential to revolutionize the biking culture at Dartmouth and in Hanover.

In sum, the Bike Repair Shop, partnerships with Wellness at Dartmouth, and various social incentives all have the combined potential to effect positive change in the way that Dartmouth employees and graduate students commute to campus. We recommend Dartmouth focus on commuter needs when considering incentives, as students are more likely to walk then drive while employees are arriving in Hanover from greater distances. Getting Dartmouth to shift its commuter to one that embraces biking will have a multitude of positive impacts, both for the environment and for personal and social well being.

Part 1B: Encouragement For Alternatives to Student Parking at Dartmouth

Introduction

As dependency on automobile travel has grown, Dartmouth policies have reinforced various ordinances to accommodate the growing parking demand on campus. According to the 2009 Dartmouth College Parking and Commuting Survey, though there have been noticeable parking usage declines due to gas prices, commuter programs and policy change, 95% Dartmouth employees still get to and from work by car⁷⁵. While problems like driving might not be a major concern in comparison to the overall operations of the College, good parking and driving practices could certainly stimulate significant positive impact to our campus life, as well as the lives of local community in Hanover. Reducing driving behavior on campus aligns with the many initiatives the College has set forth to achieve, such as reducing the campus's total traffic congestion and excessive reliance on automobile transportation, creating more pedestrianfriendly campus, and providing more green space by limiting construction cost for new parking⁷⁶. Currently, Dartmouth College strives to create a more environmentally sustainable campus, which is contradicted to the exceeding number of cars and parking lots on campus⁷⁷. Based on the 2013 Dartmouth College Campus Master Plan: Traffic Demand Management (TDM) Strategies report, 7.9% of Dartmouth employees rideshare (6.8% carpool and 1.1% got ride or were dropped off), which is lower than the average ridesharing statistics in the United States (11%). The report asserts, by assuming a \$25,000 cost to develop a new parking space, taking 126 cars (to increase rideshare by 4%-5% to meet up with national standard, which corresponds to about 200 commuters and a reduction of 126 cars) off the road would be a cost saving to Dartmouth of at least \$3 million. Although vehicle emissions contribute to comparatively a little to Dartmouth's total emissions, driving is still a very visible contributor to the carbon footprint on the overall scale at Dartmouth. According to the Hanover Town Pedestrian and Bicycle Master Plan,

Driving is a major contributor to air, water and land pollution and climate change. Walking and bicycling promote a more sustainable and healthy environment because they are both zero emission modes of transportation⁷⁸.

⁷⁵ Dartmouth College Parking and Commuting Survey, 2009.

⁷⁶ Pedestrian and Bicycle Master Plan, town of Hanover, NH 2011.

⁷⁷ Space Management at Dartmouth, 2013.

⁷⁸ Ibid.

Hence, limiting the number of cars used on campus would definitely bring positive social change and fostering an environmentally sustainable lifestyle among the College members.

Among the many initiatives the College has put forward for parking, one way to achieve such a goal is by addressing the overuse of cars on campus. The amount of driving by students, faculty, and staff in the process of getting to and from campus, as well as between points on campus, is contributing substantially to the greenhouse gas emissions on campus. Driving a car could also lead to other negative impacts on campus, for example: congestion, safety concerns for pedestrians and bicyclists, infrastructure, and maintenance costs, all of these could be easily worked around if we limiting the amount of vehicles we have on College campus. The way we move to, from, and around campus also influences the aesthetic and environmental quality of college grounds, most notably the land on campus that is covered by parking lots.

This report, while talking about parking practice in general, is specifically targeted to the driving and parking behaviors of Dartmouth students. Dartmouth College is closely knitted with the town Hanover, and many trips on campus could be easily made by walking or biking. Thus, if we reduce the number of vehicles students bring on campus it could have significant impact on the College goal of saving construction cost for new parking and creating more green space on campus. This report will help the College to understand the current situation of automobile uses on campus, the effects it has and some possible solutions to reduce student's cars on campus.

Transportation History

In 1971, Dartmouth opened its first Parking and Transportation Office with just two employees and two trucks. However, in 2009, the Parking and Transportation Office expanded to include seven employees and added an entire VOX vehicle fleet⁷⁹. Over the years, the Parking and Transportation Office had worked closely with faculty, staff and employees to improve parking and transportation programs that best meet required parking demands on campus. For instance, there is the Blue Ribbon Parking Commission in 1944 and in1984 the Advance Transit is established to provide alternative commuting options for staff and employees; in 2001, the Town-grow traffic model is created; in 2003 the Town Master Plan was adopted to reduce excessive reliance on automobile and in 2008 the college expanded commuting options by \$4/gal⁸⁰. At the same time, there have been ongoing conversations between different offices at Dartmouth to regularly discuss barriers, issues, opportunities, incentives, alternatives, core improvements, and information/education workshops and recommends better management of parking and transportation on campus. Given the isolation of Dartmouth campus and its unique existence in the town of Hanover and Upper Valley, the issues of campus driving and mobility also appears as different from those of other schools. Dartmouth campus is within half an hour away from nearby commercial centers, and the advance transit only runs from 8:00AM- 4:30PM Monday through Friday. Therefore, it makes automobiles an important mode of mobility for both students and faculty who wants to go outside of Dartmouth. In addition, Dartmouth campus also welcomes high number of traffic volumes on a daily basis both by the visitors and regular parking usage by the faculty, staff and employees⁸¹. All of these combined make parking an urgent problem on Dartmouth campus.

The first parking lot at Dartmouth was constructed in 1971 to provide parking for employees on campus. Later, when more parking was required at Murdough Center and DHMC, the Trustees announced that free funds for the college should not be used to subsidize the parking program⁸². In order to respond to this growing demand of required parking, the College moved most of the undergraduates to off-campus peripheral lots; moved graduate students at the Tuck area to a new off-campus lot and constructed a multi-story garage in the Medical area, providing

⁷⁹ Dartmouth Parking and Transportation Service website: http://www.dartmouth.edu/~fom/services/parking/.
⁸⁰ Ibid.

⁸¹ Dartmouth College Master Plan: Green Traffic Circulation Assessment 2013.

⁸² Dartmouth College, Offices of Administration, 1971.

250 more college spaces⁸³. In 1980, the college implemented a place stricter parking regulations and enforcement to adjust the crowded parking on campus. Parking fee was also raised from \$ 52 to \$84 for faculty and Administrative officers, and \$20 to \$30 to staff members. Another significant change is that employers are only allowed to bring one vehicle to campus at any time⁸⁴.

According to the Hanover Town Pedestrian and Bicycle Master Plan, over 90% of Dartmouth undergraduates live on campus; this percentage has increased significantly over the last 10 years with the college's construction and improvement of housing on campus⁸⁵. As of Spring 2014, Dartmouth has a total of 3,061 parking spaces on campus: 2,149 for employee parking and 912 for student parking⁸⁶. In 2013, the Facilities Operations and Management Office issued 384 parking permits to undergraduate students and 388 parking permits to graduate students⁸⁷(See Figure 002). Undergraduate Students who register their vehicles pay a \$168/year, \$42/term fee for a parking decal that specifies in which lot they may park. In contrast, for faculty and staff members, it varies from \$2 per credit/hour to \$12 per credit/hour. First year undergraduates are not allowed to bring a car to campus, and undergraduate students must park in A-lot (East Wheelock near Burton Road). All College students bringing motor vehicles to Hanover must register with the parking office, there is a \$50 fine per term for any student failing to register for campus lots or for off-campus parking. There is no charge to register for off-campus parking (sororities, fraternities, and private homes).

⁸³ Ibid.

⁸⁴ Ibid.

⁸⁵ Ibid.

⁸⁶ Robin Guay, personal interview, May 11, 2014.

⁸⁷ Ibid.

Problem Identification

Though many seem to overlook the issues of students' driving and parking on campus, survey data collected from community members indicated that there is a growing concern of student parking behavior at Dartmouth. The 2009 Dartmouth College Parking and Community Survey⁸⁸ demonstrate some direct feedback from college commuters.

Comments from on-campus employees "Remove student or non-commuter or improperly parked cars quickly" "First year students should not have cars and if they do, they should park in off-campus lots. Faculty who cannot find parking on campus are going to work at home more, and may already do, thus further undercutting the liberal arts college atmosphere" "I understand that the students are the reason we are here and the reason we have a job. But I find it very frustrating to find students parking in employee parking" "Parking fines should be raised and enforced for student to not park in college lots during business hours. If students can afford to have their own car on campus while living in the dorms, they can afford to pay higher fines for parking in college staff/admin/faculty lots. It's VERY frustrating to arrive at work and see students' car taking up very valuable parking spaces that we pay for"

"Really penalize students for parking in faculty parking spaces during the week"

While allocating these frustrations with specific student groups is difficult, the direct feedback from the campus employees further stresses the importance of addressing student parking issues at Dartmouth. In the following section we will look at different data containing a variety of both directly and indirectly related variables including why students drive on campus, their parking locations, accumulation of parking tickets, and information on student affiliations in Greek houses (sororities, fraternities, and private homes). By looking at this information, we gain a better understanding of how to best reinforce parking policies at Dartmouth and ultimately encourage students to not bring their vehicles on Dartmouth campus.

⁸⁸ Ibid.

Recommendations from Other Schools

After researching some other schools in the Northeastern region, namely Princeton University, University of New England, University of Maine, Bowdoin College, Bentley University and University of Vermont, it is clear that the parking model used at Dartmouth is very similar to those other schools in New England. For instance, most schools keep the majority of their student parking lots at the periphery of the campus, with a small number of faculty lots and visitor lots allocated in the center of the campus. Another interesting aspect of these schools is that they prohibit freshmen and sophomore students from bringing their cars on campus with very strict parking regulation. For instance, at Princeton, undergraduate freshmen and sophomores are not permitted to have a vehicle on campus, and the cost of parking is \$200/year, which is much higher than Dartmouth \$168/year. At Bentley University, freshman resident students are not allowed to park their vehicle on campus. A student bringing an unregistered vehicle onto campus will be subject to judicial action, loss of parking privileges, and/or ticketing and towing. At the University of New England, though there is no particular polices for students to not bring vehicles on campus, after implementing series of alternative transportation programs, the university saw number of freshman that brought cars to campus decrease from 75% to 25% in first year of providing free bikes⁸⁹.

This finding mirrors many other facts collected in our research, which suggests that schools that have stricter student vehicle policies usually come hand in hand with very successful bike share or other transportation programs. For instance, at Princeton, on March 1, 2013 their Undergraduate Student Government (USG) and Campus Policy Office hosted a Bicycle Safety Event to give out free bike locks and helmets to students, the Transportation and Services Office also assisted students with campus bike registration and a total of 51 bikes were registered at the event⁹⁰. At the University of Maine, the free bike share program repairs abandoned bikes, and signed out bikes free of charge (with a bike lock) to anyone with a MaineCard. When the bike is lost or stolen, the student is charge a \$100 fee is assessed to the responsible person's account. This program resulted in a 95-space parking lot turning into a basketball court⁹¹. Similarly at the University of New England, the school offers free bicycles to the first 125 deposited freshmen

⁸⁹ University of New England website: < http://www.une.edu/news/2010/unebicycleprogram.cfm>

⁹⁰ Princeton University website: http://www.princeton.edu/transportation/regulations.html

⁹¹ University of Maine website: <http://www.uvm.edu/~tpswww/>

that live in the Residence Halls and gives a free Electronic gift card worth \$225 ZipCar usage for those Freshmen, Sophomore or Junior who opt to leave their cars at home and join the ZipCar program. The University of New England also has a bicycle club offering tours throughout the seacoast, bicycle rentals, repairs and storage. As noted at above, because of these programs, the UNE was able to decrease the number of students bring their vehicles to campus from 75% to 25% in first year of providing free bikes⁹².

Data Gathering

From the data collected in the 2009 Commuting and Parking Survey plus interviews with Robin Guay from the Facilities Operations and Management Office, Rosi Kerr from the Sustainability's Office and Joanna Whitcomb from the Office of Campus Planning, it is clear that limiting the number of student vehicles on campus could benefit greatly to the current parking practice on campus and create an environmentally sustainable lifestyle among the college members. In order to capture an accurate data and directly get feedback from students, survey data were collected among the undergraduate students on information about how many students had cars on campus, their vehicle parking locations, the reason they brought cars on campus⁹³ and what alternative transportation option they might prefer⁹⁴. These surveys were to determine the mentalities and habits associated with student driving on campus and what idea would likely be the most popular among students.



Figure. 001 Distribution of Student Car Use at Dartmouth College. Our data collected from the "Student Biking at Dartmouth" survey indicates 54% student's vehicle trips on campus could be made by biking and walking.

⁹³ ENVS 50 Class. "Student Biking at Dartmouth." Survey. April 2014

⁹⁴ ENVS 50 Class. "Driving a Car at Dartmouth." Survey, May 15, 2014.

Analysis of Campus Parking

According to Robin Guay, as of Spring 2014, there are 22 parking permits given to first year students, 362 to not first year undergraduates, 295 to first year graduate students, 373 to not first year graduate students and 93 DMS students (Figure.002). According to the survey, 390 number of students participated, and the result helps us to ensure the most relevant data is collected in the survey.



Figure 002. Distribution of student parking permits at Dartmouth



Figure 003. Distribution of parking tickets issued to students



Figure 004. Distribution of user parking on A-lot, sororities, fraternities, and private homes. This data is collected from the "Driving a car at Dartmouth" survey amongst undergraduates who owns a car on campus.

Possible Solutions

Combined with some research from other schools, as well as the student driving and parking trend at Dartmouth, we concluded that in order to implementing stricter parking regulation to Dartmouth students, alternative transportation program needs to be in place to accommodate students' demand traveling on and off-campus. Therefore, the following chart (Table 001) is made to learn about what other schools have done and what we think Dartmouth could do:

SCHOOL	STUDENT PARKING	INCENTIVE	BFU
	POLICY	PROGRAM	CERTIFIED
Princeton	1. Freshmen and sophomores	1. A wide array of bike	
University	are not permitted to have a	paths and walkways	
	vehicle on campus.	throughout the campus.	
	Upperclassmen are not	2. The campus provides	
	allowed to register a	more than 3,600 spaces	
	vehicle on behalf of a	for bike parking. Bikes	
	freshman or sophomore.	that are not parked in	
	2. Parking for undergraduate	assigned parking lot may	
	students is permitted in the	be subject to a fine.	
	periphery of the college.	3. Provide bike lock	
	3. Student parking is	removal service for	
	\$200/academic year.	registered individuals	
		who have lost their lock	
		keys.	
		4. The Moving & Storage	
		Agency provides bike	
		pick-up and storage for a	
		fee of \$50, with optional	
		\$5 insurance.	
		5. Every week on Tuesdays	
		and Sundays, volunteers	

Table 001. Parking Polices and Incentive Programs

		are available to teach and	
		assist everyone with bike	
		repairs free of charge.	
		6. Free bike locks and	
		helmet	
University of New	1. No particular rules about	1. Admission tours of	
England	students bring their cars on	campus by bicycle to the	
	campus	prospective students and	
	2. Resident students can only	their families.	
	park in a designated	2. Offering free bicycles for	
	Resident lot.	first 125 deposited	
		freshmen who live in the	
		Residence Halls.	
		3. A free Electronic gift	
		card worth \$225.00 for	
		ZipCar usage for those	
		freshmen, sophomore or	
		junior students who	
		promised not to bring	
		cars to campus.	
		4. Free bicycle rentals, a	
		"Blue Bike" program,	
		and student bicycle tours	
		throughout the	
		surrounding area.	
		5. With all the programs,	
		UNE converted a	
		parking lot into	
		recreation space without	
		the need for additional	
		parking.	
University of	1. Students parking passes are	1. Blue Bike Share	
Maine	\$50.00 /year and only park	Program: abandoned	

	in designated area (No	bikes are repaired,	
	particular rule for freshmen	painted blue, and signed	
	or sophomore)	out free of charge (with a	
		bike lock) to anyone with	
		a Maine Card. If the bike	
		is lost or stolen, a \$100	
		fee is assessed to the	
		responsible person's	
		account.	
University of	1. First year students are	1. Mr. Your Bike Program:	
Vermont	prohibited from bringing a	free bike lights and patch	
	car to campus. Exceptions are	kits to attend a free bike	
	granted based on medical	maintenance class. Free	
	need.	safety gear coupon.	
	2. Transfer students must	2. Bike Share Pilot	
	provide proof of two full-	Program: check out bikes	
	time semesters at another	for free for four hours at	
	higher education institution if	different bike hubs on	
	they are considered first year	campus. (With UVM ID)	
	students at UVM to get	3. Bike Users Group	
	parking permit.	(BUG): free bikes for	
	3. Student parking rate:	everyone, support bike	
	\$55/month, \$180/semester,	share, provide free	
	and \$330/year	services.	

Bowdoin College	1.First year students do not get	1.	Yellow Bike Club: 80	
	parking permit and are not		new and used bikes to	
	allowed to register any		rent out to students,	
	motorized vehicles on		faculty and staff	
	campus.		members at Bowdoin.	
	2. Students are only allowed to	2.	Providing YBC members	
	park in student parking lot at		with bicycles,	
	anytime. Parking in employee		maintenance, and free	
	and visitor lots during		storage of the bikes	
	business hours is prohibited.		during the school year	
			for the low cost of \$25.	
Bentley University	1. First year resident students	1.	12+ bike racks across	
	are not allowed to have		campus	
	vehicles on campus.	2.	Bike Apps: BikeMate	
			Pro, Map My Bike,	
			Weather Channel App	
			and Bike Repair App for	
			students, faculty and	
			staff.	
		3.	Strong bike culture	
			among the college	
			members.	
	DARTMOUTH C	OI	LEGE	
Dartmouth College	1. First year resident students	1.	The DartBike Rentals:	X
	are not allowed to have		\$10/week and \$100/term	
	vehicles on campus.		(with lock).	
		2.	Used Bike Rental	
			Program: \$25/term.	
	Recommenda	tio	18.	
1 Further enhance stricter narking regulations for freshmen students bringing vehicles on compus				
2 Policies and ince	entives that encourage public trans	nor	tation walking and biking a	is well as

disincentives for driving alone trip-making

- 3. Providing incentives for freshmen students to bike and walk more on campus (e.g. give out free bikes, discount on renting bicycles, give freebies to students and advertising alternative transportation programs at Dartmouth)
- 4. Incentives for carpooling, ZipCar and Zimride for sophomore and juniors on their off-campus trips so that they do not need to bring a car on campus
- 5. Raise parking fee near the center of town and Greek houses to encourage students to park farther away from campus. Assure people paying the lower price do not park in the closer lots
- 6. Improved infrastructures: safe sidewalks, bike racks, bike lanes, bike sharrow symbols on selected roads surrounding the campus, signs and signals, etc.

In addition to the recommendation made above, when asked about preferred alternative transportation options on campus our data indicates very high percentage of students choosing free bikes (15%), free bike sharing program (12%), free ZipCar usage gift card (15%) and advanced transit during weekends $(13\%)^{95}$. Therefore, this result reinforces the idea that by providing well-integrated public transportation network, students are very likely to opt to bring their cars on Dartmouth campus.

Conclusion

Through this research, we concluded that a well-established transportation network is the key to implement stricter student parking policies at Dartmouth. According to the data collected in our surveys, 56% of students' vehicle trips on campus could be easily made by walking and biking (See Figure 001). By providing alternative transportation models on campus, it:

- Offers convenient transportation options for students when they need a car
- Builds environmentally sustainable campus and creates more green space
- Ensures easy access to the programs for all community members
- Cultivates a bicycle friendly culture where everyone feels proud to bike and walk on campus.

Therefore, when other transportation options and infrastructure are in place, it becomes easier for students to leave their cars at home and for the school to prohibit student vehicles (especially freshmen and sophomore) on campus. In order to put forward such parking policies at Dartmouth, we hope the College will take into consideration of all the recommendations we make in this joint report and work to provide a more sustainable transportation practice at Dartmouth.

Encouragement Conclusion

This section has stressed the importance of Encouragement as a means of motivating people to understand and reap the benefits of cycling. Encouragement is multifaceted in that it serves to improve the experience of current cyclists, making them more excited about their commitment to biking, and also change behavior to incentivize new cyclist commuters. As stated above, a bike culture will not grow without programs to encourage regular bike commuting. The three main topics that we addressed in this section were:

- 1. Perceptions of bicycling on campus and understanding why commuters and students do and do not ride
- 2. Proposing a cost-effective Bike Share program at Dartmouth, paying particular attention to accountability and maintenance for students.
- 3. Incentives such as Zap boxes, the Bike Repair Shop, and benefit and social programs for commuters at Dartmouth to foster a culture where biking is more accessible and acceptable.

Our qualitative research from our surveys and interviews has provided us with many diverse perspectives surrounding biking on campus. Through talking to cyclists and non-cyclists directly, we have been able to evaluate the most important needs of the Dartmouth community and address them in our solutions. This section evaluated the current climate at Dartmouth regarding biking and summarized the suggestions of students and staff about how to improve cycling programs in a sustainable and productive way.
Part 2: Education

Education Introduction

According to the National Highway Traffic Safety Administration, 677 cyclists were killed in traffic fatalities in 2011. Of those 677 fatalities, 91% were over the age of 14⁹⁶. Given the number of adult fatalities, it is surprising that we can learn how to ride a bike and get on the road without having to formally learn traffic and safety rules as we would for any motorized vehicle. This is why one of the most important steps in creating a thriving bike culture at Dartmouth College is making sure cyclists are not only passionate about riding their bikes, but also knowledgeable about general bike safety, road rules and even maintenance. Increasing the number of educated cyclists may reduce or at least lessen the severity of injuries and is necessary if we want to create a lasting bike culture. In the same vein, many of us have been taught how to ride a bike, but not how to maintain it. As a result, many bikes do not last to their full potential and are abandoned prematurely, leading to unnecessary waste. This is very apparent on college campuses. In order to address these issues and create a bike culture at Dartmouth that is both safe and sustainable, we discuss in the following sections ways in which Dartmouth College can implement bicycle education to move us forward in sustainability and safety. Our research has led us to suggest the following: an improved Biking at Dartmouth Website, a bike maintenance workshop, a PE class, and the addition of a mandatory education component to current bicycle rentals. These sections are accompanied by brief outlines of the successes and failures of past initiatives, which have informed our final recommendations.

⁹⁶ "Bicycles." . National Highway Traffic Safety Administration, 1 Jan. 2011. Web. 12 May 2014. ">http://www.nhtsa.gov/Bicycles>.

Website

Green Commute: What was useful, what was not

While the Dartmouth Green Commute website (http://sites.dartmouth.edu/greencommute/bike/) is very useful, we believe it is lacking many fundamental components that a successful biking at Dartmouth website should have. First, it is important to note that the green commute website is not specifically aimed towards students, and as such, it contains information about commuting via bus, walking, rideshare, and even air transportation. However, the website only contains minimal information about biking, especially as it relates to students. Furthermore, the website is outdated, poorly publicized, and is not user friendly. Even if the website were to be updated with new information, we still believe part of the problem is the platform being used, which makes it unappealing to visitors. All of the information currently on the bike subsection of the green commute website is extremely useful and should be integrated into the new bike website. Currently, under the bike subsection of the green commute website, there is information about the Dartmouth Bikes Program, campus bike policies, laws and safety guidelines, and resources for cyclists.

Under the Dartmouth Bikes subsection, information is provided regarding how the program:

- Refurbishes abandoned bikes that have become property of the college
- Resells refurbished bikes to students, faculty, and staff
- Reduces bike waste on campus
- · Hosts educational workshops about bike maintenance and safety

Under the Campus Bike Policy subsection, information is provided regarding policy, which includes:

- Bike Registration
- Permitted Parking and Storage
- Unauthorized Parking
- Abandoned Bikes

Under the Laws and Safety Guidelines subsection, information is provided by means of a link to nh.gov (http://www.nh.gov/hsafety/publications/documents/bicycle.pdf).

Under the Resources for Bikers subsection, information is provided regarding:

- Where to purchase winter biking gear
- Where to purchase cheap, second hand bikes
- Where local bike shops are located
- When and where the pop-up bike station is stationed
- Where to find other cyclists in town to ride with

All of this information is extremely useful for biking on campus, and will be utilized and integrated into the new website. However, since the scope of this information is very limited, we suggest that several new components be added to a new website in order to deliver a comprehensive and more user-friendly interface. Our recommendations for what should be added to a new biking website can be found under the "New Website Content" section that follows.

New Website Content

Bike Routes Around UV

In order to provide cyclists, particularly commuters, with biking options, the new biking website should contain its own interactive route finder. Providing easily accessible maps of routes around the Upper Valley will not only encourage more cyclists to venture outside of the Dartmouth campus, but it will also inspire more confidence in the cyclists who already commute. Presently, The Upper Valley Trail Alliance (http://trailfinder.info/uppervalley) based in Norwich, Vermont has an interactive route finder that shows the various Upper Valley paths currently available for use and each path's purpose. While the Dartmouth Green Commute website provides a link to this site, it is not easily visible and as accessible as it should be. The new biking website would contain a similar interactive tool to the Trail Alliance website's, and the Upper Valley Trail Alliance could provide both information and planning support for the new website's manager. Just to provide an example of one of the routes, one major route of significance, the Upper Valley Commuting Trail, navigates a full loop trail that experienced bike commuters have tested and feel to be the optimal course for Upper Valley bike commuting (UV Trail Alliance Website).

This is an example map of this loop, which shows the connections between the major towns of Hanover, Lebanon, Hartford, and Norwich⁹⁷:



Instead of just providing links to the Upper Valley Trail Alliance website, we propose that either a new search tool is created, or that the maps are taken directly from this search engine and placed on the new website for ease of access. By placing the maps directly on the website, there will be a higher level of accessibility, and students and commuters will be more likely to utilize this feature. On the website, these maps will be interactive, rather than static. This way, users can zoom in to see exactly where the paths are, and they can work on creating their own routes that are tailored to their specific needs. In addition to these maps, the engineering group has gathered student responses of where Dartmouth students travel most. Therefore, we can use this data to make campus maps as well.

⁹⁷ "Trail Finder". Upper Valley Trails Alliance, 1 Jan. 2014. Web. 26 Apr. 2014. <trailfiner.info/uppervalley>.

First Year Page

For students arriving on campus their freshman year, purchasing a bike may not be high on their list in terms of priorities. However, after adjusting to the college campus, many students find that having a bike would be advantageous. For example, many students participating in athletics have to commute from their dorm to their classes to their training facility, often with little time in between. As such, bikes can be very useful. Additionally, students residing in dorms such as The River Cluster have to travel quite a ways to get to classes in buildings that are fairly distant, such as the LSC. While many freshman will realize that they do not need a bike, the reality is that many first years would like to own a bike, but don't know the first place to go for one. As the first part of the "First Year" page, information about where to purchase bikes would be presented. Our first recommendation is for students to utilize the Dartmouth Bike Share: not only will students save money, but this also reduces waste. If students choose to purchase a new bike, there are several bike shops very close to Dartmouth, and many are easily accessible by riding the AT. Among these bike shops are Omer & Bob's, located in Lebanon, NH, The Bike Hub in Norwich, VT, Eastern Mountain Sports in West Lebanon, NH, and Morris Brothers Mountain Bikes in White River Junction, VT. These bike shops offer a wide selection of road bikes and mountain bikes for a wide range of riding abilities. Although these shops are easily accessible, the bikes that they sell are often costly; however, there are also other options for purchasing bikes. Both Wal-Mart and K-Mart in West Lebanon, NH sell bikes as well. These bikes are not as high quality as bikes sold by more specialized shops, but they can last a fairly long time if maintained properly. Additionally, these bikes are extremely affordable and make for a great entry-level bike if it is a student's first time purchasing a bike. If a student is unsure whether they would like to purchase a bike, there are also rental options available.

While purchasing a bike is an important first step, students also need to be educated on where to buy parts for their bikes. If a student is to run into an issue with their bike, we hope that by visiting this website, most of their questions about how to repair a bike can be resolved. As far as where to buy parts such as chains, tires, reflectors, etc., Omer and Bob's, The Bike Hub, and EMS all offer these.

Many freshmen are unfamiliar with where to bike on and around campus. As such, on the first year page, there will be a direct link to a trails page with popular routes in the Upper Valley. In addition to all the basic elements of the first year page, there will also be short videos on many

aspects of biking an inexperienced or first time rider might not think about. These videos would cover certain things like: what kind of locks will work with your bike to ensure it is protected from theft, where can I store my bike when I take an off term, what is the correct way to ride safely, etc. Finally, in order to expand ridership among first year students, we would like to implement a blog or Facebook group tied into the page where members of the freshman class can communicate with each other, exchange parts and ideas, and even link up for rides.

Incentives

In order to further promote bike registration, individuals who sign up will be able to get free hot or cold drinks (season-appropriate) twice a month and be invited to a social event with free food at the end of each month. The costs of these benefits per person are minimal. They will also be put on the blitz listserv from which they will receive notifications about safety campaigns, maintenance tips and pop-up shop information, and social gatherings for cyclists.

Bike Forum

In addition to the current web pages being outdated and lacking cohesion, they are not interactive and engaging to students. To address the latter, we propose that in addition to joining and renovating the information which already exists online, a new website should include a forum that serves as an informal and interactive resource for undergraduate and graduate students, faculty, and staff. This forum would allow members of the Dartmouth community to post and respond to specific bike-related queries that may not already be addressed on the website. Possible topics include:

- 1. **Bike sales and lending:** Dartmouth members can put up their bike for rent or sale during off-terms or in anticipation of graduating; they can make requests to borrow a bike, bike tools, or spare bike parts.
- 2. Bike buddy set-ups: Dartmouth members can organize group rides.
- 3. **Safety alerts:** In addition to the road safety alert provided by the Upper Valley Trails Alliance, the forum could also be used as a place for conscientious cyclists to alert others to dangerous paths and temporary hazards they have come across.
- 4. Random bike questions: from repair questions to questions on specific routes.

 Bike News: Members can post to share bike-related news and events (i.e. advertise local biking events or share information on cool bike programs being implemented at other colleges and cities).

In general, it is hoped that the Bike Forum will serve to further foster a community of conscientious and connected bikers at Dartmouth.

Current Situation

Currently, there exists a DOC mountain-biking sub-club social list that is used to email to group members about topics 1-3. This list is small, only open to students, and geared towards very experienced cyclists. Alternatively, the Bike Forum aims to serve as a resource for all levels of cyclists and the whole Dartmouth Community. The forum page allows older posts/queries to be easily viewed, whereas email chains, like those of the DOC biking email list, are easily lost in your inbox.

Maintenance

While the interactive forum page would largely be a place for peers and Dartmouth community members to communicate and answer each other, it will be helpful to have a manager to make sure no one is misusing the site in any way. One of the Sustainability Office's Bike Interns or an assigned bike website manager could serve as this manager. This person should sift through the site every once in a while to answer any questions they can that have remained unanswered. In addition, this manager should moderate bike sales and purchases made through the forum so as to prevent the sale of stolen bikes. Bikes to be sold should be confirmed with the manager as college registered.

Bike Maintenance and Bike Policy

As mentioned earlier under the "Bike Maintenance Workshop", many Dartmouth students do not have enough knowledge about how to maintain, repair, or even store their bikes properly. We have come up with two more mechanisms in conjunction with the website, on how we can educate students on simple ways to maintain their bikes in order to remain safe on campus. This is why we will include maintenance videos on the website to help students follow step-by-step instructions on repairing their bikes to keep them prepared for riding on campus. We borrowed this idea from the American League of Bicyclists' website, which has its instructional videos under its "Ride Smart" section. It is supposed to develop students' knowledge of biking safely through the interactive video lessons. This is crucial, considering that education has been the core of the League's goals. Therefore, it is also best we implement this into the website's education page. It would make sense to make viewing of these videos available on a monitor screen in Robinson Hall (Robo) where there are tools available for anyone to repair or maintain their bikes. We think this is necessary because students on campus are assumed to know how to maintain and repair their bike. Some checkpoints on their bikes that students need to be aware of include the following:⁹⁸

Fitting and Adjusting a Road Bike

Frames have fixed dimensions; road bikes need 1-2" of clearance between the rider and the frame while mountain bikes should have 3-4" of clearance. Your knee should have a slight bend to it when sitting on the bike and pushing the pedal all the way down.

How to Maintain a Road Bike

- 1. Check the skewers on the bike to make sure the wheels are on right and tight enough by pulling them back, then closing them once again.
- 2. Make sure the tire is aligned properly in the front.
- 3. Brake pads are properly aligned, so as they touch the rim and not the tire itself. Otherwise a blowout could occur.
- 4. Do these steps similarly to the back of the bike; check that the skewers are nice and tight by pulling them back and closing them.
- 5. Check that the skewers on the bike are centered and the braking pads are serviced on the bike.
- 6. Check that the headsets on the handlebars are tight by grabbing the front end and holding down the brakes to see if one hears any noise.
- 7. Check that the seat does not slip and that it has proper tire pressure.

⁹⁸ See the League of American Bicyclists' Instructional video "Fitting and Adjusting Your Bike" under Ride Smart, http://bikeleague.org/content/fitting-and-adjusting-your-bike.

8. Finally, check the chain to make sure it is aligned properly on the bike and that it is not rusted or full of "gunk".

After these basic maintenance procedures have been checked, if anything needs to be repaired students can watch the tutorial videos on how to use the tools that will fix their bikes. For example, if a student finds that he or she needs to tune his or her breaks and gears, then a video could easily help them see where they would start in doing so. This could include replacing worn out bike pads, resetting cable positions to just touch the rim of the bike, and tuning up the gears again. Also, tuning the bike gears to make sure the chain runs smoothly, by listening to see if you hear any noise when shifting gears. The rear of the bike has "limiter" screws to control the tension and set of the bike. This type of information in videos is beneficial for students to know and stay safe while riding their bikes.

However, the instructional videos should not just stop at basic bike maintenance. There will also be videos for bike riding tips and safety, such as "shifting gears", "starting and stopping", "scanning", "signaling", and "steering". This is why our videos should be accessible anywhere through our educational website and the mobile app. Our videos will also include tips to understanding basic bike policy. Many do not know about what bike policy entails, but knowing the rules of bicycling is just as important as knowing the maintenance details. Bike policy videos would include the following:

Better Bicycling:

- 1. Lane changing and bike lanes
- 2. Traffic laws
- 3. Riding on the sidewalk
- 4. Knowing what a safe route to ride would look like

Educational videos are only a small portion of the website, but they are a great place for students to start and build their confidence in being "Bike Friendly". These instructional videos can even be a requirement to watch for students who would wish to rent a bike from the Alumni gymnasium or anywhere else on campus. They are easy to follow and do not consume as much time as a class that would teach all the same instructions would. Furthermore, these videos could be a requirement that students must watch on the website before registering their bikes. We plan on having Dartmouth students who are already knowledgeable to remake these videos, or borrowing these videos from the American League of Bicyclists' website under their education section. The rules of online bike registration will be talked about more in the next section.

Bike Registration

Dartmouth students currently register their bikes for free through the Safety & Security office by filling out a registration form and turning it back into the office. According to Dartmouth's Department of Safety and Security, bicycle registration helps prevent bike theft on campus. It would be easier to return/identify a stolen bicycle with the following information once the loss has been reported. The following information is required to register one's bike:

- Make (Manufacturer's Name)
- Model
- Color(s)
- Number of Speeds
- Serial Number (usually found on the bottom of the frame between the pedals)
- Value (Either purchase cost or replacement value)
- Type (mountain, road bike, hybrid, race bike)

ace Bike		

Although this is a simple process, we believe an online registration would be far better. This way, when a student is required to register his/her bike, they can also be required to watch the bike policy videos before registering their bicycles. Also, the ability to access one's bike information electronically is more efficient because Safety and Security can pull up the information anywhere on campus. It is also more convenient for students to update their registration forms. The bicycles will be registered online by freshmen and returning students who just purchased a bike. This will also incentivize students to have to use the website and encourage them to use it as a reliable resource on campus. Some things we did not consider in making this section of the website are if faculty, staff, and graduate students should have a separate section on the website for the registration forms.

Management

Dartmouth needs one fully inclusive website that resides within a single department that will routinely update its content and that will make the website easily accessible to the

⁹⁹ "Bicycle Registration". Department of Safety and Security, 4 June 2008. Web. 30 Apr. 2014. </br>www.dartmouth.edu/~security/services/bikereg.html>.

Dartmouth community. As of now, a few individuals and groups within the Dartmouth community manage different biking websites. However, not all of these websites are up to date or contain consistent information. Additionally, users have difficulty finding their desired information since the current websites are fairly hidden under other content and different pages. People new to biking find it particularly challenging to find information since they're unsure of where to start looking. For example, Dartmouth's Office of Facilities Maintenance website (http://www.dartmouth.edu/~fom/policies/bicycle.html) contains some information about Dartmouth specific biking policy, such as bike registration, but displays information in a dull old fashioned manner and lacks information about on campus bike rental options. Another Dartmouth website called Green Commute (http://sites.dartmouth.edu/greencommute/bike/), created by a Dartmouth College presidential fellow who worked in the Office of Campus Planning in 2013, contains remarkably useful information about Dartmouth biking policy, initiatives and maps to the greater Dartmouth community. Moreover, Green Commute contains useful information about rideshare programs and alternative transportation incentives specific to Dartmouth's community who potentially combine more than one alternate mode of transportation for their travel requirements. However, Green Commute remains generally unknown by the Dartmouth undergraduate population even though the website launched in July 2013. Furthermore, the Office of Campus Planning lacks a staff member dedicated to campus transportation planning so the college currently fails at providing a management structure for alternative transportation systems, including the Green Commute website. A site used more heavily by undergraduate students is Dartmouth Outing Club's website (http://www.dartmouth.edu/~doc/roadbiking/), which contains biking tips and information about mountain bike rentals, but fails to provide information about Dartmouth and New Hampshire specific policies. The site focuses more towards mountain cyclists and recreational biking than transportation biking.

The best option to adequately publicize a Dartmouth biking website, ensure its maintenance and spark interest among all groups of the Dartmouth community is to have the Dartmouth College's Office of Sustainability maintain an all-encompassing biking website as part of their overarching website. Presently, the Sustainability Office has four undergraduate bike interns who run the bike rental program, research ways to improve biking at Dartmouth, run popup bike maintenance shops and educate the community about biking. These interns will

maintain the new all-encompassing website because these interns understand the campus biking culture, know new and old initiatives and will gain valuable employment skills like website troubleshooting. Additionally, the four interns can work together to maintain the website so that it remains constantly updated and no one person holds the burden of continually maintaining the website's content. As a central location for students, faculty and staff as well as community members looking for information about Dartmouth's sustainable practices and initiatives as well as the owner of Dartmouth's refurbished bike rentals and popup bike maintenance shops, the Sustainability Office is recommended as the department to house and manage the website, especially because the Sustainability Office hopes to rejuvenate its current website within the next year. This would include any future additions to the Dartmouth biking plan. In order to evaluate the website's success, the Sustainability Office should track weekly individual pages to ensure popularity, address the areas that are highly demanded and redesign pages with low hit rates. Tracking the website's hits can also help the college understand Dartmouth's biking culture by analyzing peak visitor hours and the fluctuation of unique hits. Lastly, all departments with biking websites should transfer their information to the new website and deactivate their old pages and accounts in order to force users to use the one website, advance continuity, improve management and promote a more bike friendly culture.

Advertising

In the past, Dartmouth has created and used a number of biking web pages and websites, none of which maintained prolonged popularity. Many Dartmouth community members lack awareness about the Internet resources available to them or struggle to find adequate information about all Dartmouth biking programs. Therefore, it is vital that this website's outreach expands to as many Dartmouth community members as possible. Here are the recommended advertising techniques for mainly the website but also Dartmouth biking in general.

• **Hinman Mailing:** During the website's launch, a small postcard with information about biking initiatives and the website should be mailed through the campus Hinman system to all Dartmouth members so that every individual has a copy of the website's address and a biking reference sheet future use.

- Blitz over the Listserv: The Sustainability Office should send a termly blitz to the entire campus community, including faculty, staff, undergraduates and graduate student, with biking news updates and the blitzes should also include the link to the website as a reminder of its existence and its resources. This blitz would occur the evening before each terms starts, during the time when students are getting settled, move into new dorms and figure out schedules so that students can integrate bike transportation into their daily lives.
- Social Media Through the Sustainability Office: The Sustainability Office should post new biking programs and incentives to their social media pages, such as Facebook, to continually keep interest and promote biking awareness.
- Facebook Ad Through the Sustainability Office: Similarly to the Rockefeller Center, the Sustainability Office can purchase a Facebook advertisement that only appears to specific groups of people. For example, the office could state that the advertisement would only appear to those with Dartmouth College tagged on their profile.
- Semi permanent Posters: Strategically placed semi permanent posters can encourage users to visit the website while providing a stable resource for those who forget about the website's existence. Posters should be placed at Dartmouth Safety and Security Office who handles bike theft and registration, the Dartmouth Outing Club who houses frequent and avid cyclists, the Sustainability Office who controls current biking initiatives, Alumni Gym who promotes fitness experiences and overall health to a variety of patrons and the Hanover CO-OP Food Store who provides a healthy food stop for many commuters and graduate students.
- **Stall Street Journal:** An edition of the Stall Street Journal can contain the link to the website along with other important biking information to encourage a bike friendly culture on campus. Or an edition could focus on alternative transportation methods with biking, and the website, as a portion of the journal.
- **Paint on College Owned Bicycles:** The Sustainability Office's rented bikes can have the website address painted onto its bikes so that the general population can see the website when the bike is parked around campus and the Upper Valley and so the cyclist has a resource to use when he has a biking question. If the bike share initiative

is implemented, these bikes can also have the website painted onto the bike's frame, increasing the website's visibility.

- **Tags on Bike Racks:** Waterproof tags containing important biking registration, safety and regulation information as well as the website can be attached to all the bike racks on campus so that users are aware of their options almost anywhere on campus.
- Newspaper Ad: The Dartmouth, a student newspaper read by many Dartmouth community groups, allows ads and using this service will reach a broad range of Dartmouth community members at a fairly low cost.
- **First Year Mailing:** During the first year spring housing mailing, the Sustainability Office should mail pamphlets to first year students and their parents so that they know their biking options prior to buying their own bikes. This packet should include the website so that families can look over Dartmouth biking information together as often as needed.

Bike Maintenance Workshop

Many students are deterred from purchasing bikes for one simple reason; buying a bike is an investment. If an individual isn't willing or able to maintain a bike and won't get it fixed by someone else, then what reason is there to own a bike? Knowing that the bike will become less functional over time, students often forgo cycling because they lack the knowledge and skills to fix minor issues. Furthermore, bikes purchased by students that fail to maintain them often end up being abandoned, creating an unnecessary waste issue. This is an issue we are trying to address by implementing a Bike Maintenance Workshop that aims to teach students, faculty, and staff the skills necessary to repair their bikes in order to ensure their bikes will last for several years. Several schools across the United States have already implemented such programs, but with Dartmouth's academic calendar and climate being so different from many of these schools, a new program must be created specific to Dartmouth.

The first thing to address with these workshops is when they would be offered and to whom. The first workshop, entitled "Introductory Bike Workshop" would be offered to incoming freshmen during orientation. As the majority of students who purchase bikes do so when they first come to campus, they are the primary target audience of this workshop. This introductory course will only cover the basics of bike maintenance and briefly delve into safety protocols related to cycling, serving as a platform for further bike maintenance workshops. Additionally, those interested in taking the "Introductory Bike Workshop" but do not take it during Freshman orientation will have an opportunity to do so at other times as this workshop will be offered once every term within the first week of classes. Secondary workshops would be offered twice a term, available for all students and faculty/staff to attend. While the "Introductory Bike Workshop" would simply be a just the basics/intro workshop, the workshops taking place during the rest of the year would be somewhat different, and entitled "Bike Maintenance Workshop". Our hope is to have these workshops last anywhere from two to three hours, and schedule them on Saturdays or Sundays to make them convenient for individuals to attend. While everyone is encouraged to attend the "Bike Maintenance Workshop," we suggest that individuals first attend the "Introductory Bike Workshop" so that they have a more fundamental understanding of bikes before they dive into more technical maintenance.

Each of these workshops would also have different aims, or themes, though they will all cover much of the same information. Because Dartmouth utilizes a term calendar broken into quarters, these workshops could be focused on maintenance with regard to the specific season. For example, the fall workshops could focus on how to combat rain (effectively to lessen damage done to a bike). A winter workshop might be about adjusting your tire pressure to get a better grip on slick roads that may have snow on them, or keeping your chain and bike free of ice melt which can corrode many parts of a bike. Additionally, the winter workshops would detail how to properly store and prepare your bike for the winter so that it does not become damaged.

Most of the topics covered in these workshops will be similar to those covered by the video tutorials provided on the website, but will be more hands on. By this we mean that we would encourage students to bring their own bikes to work on so they feel more comfortable about repairing and maintaining them. In order to accommodate students who wish to bring their own bikes to these workshops rather than just watch, we are suggesting that the workshops be held in a large open space with audio capabilities. As such, we recommend utilizing an outdoor space such as the Gold Coast Lawn and supplementing the workshops with moveable audio. If weather should be an issue, especially during the winter, we would recommend hosting the workshop inside Alumni Gym.

The Host

With regards to who would instruct the course, our hope is to have someone with a great deal of bike repair/maintenance experience. This could be a bike mechanic who works in a local bike shop like Omer and Bob's/Bike Hub, a member of the Dartmouth Cycling Team, or a Professor that is an avid cyclist. The main thing of importance here is that the instructor is confident in teaching how to repair bikes and is extremely knowledgeable about the topics. If at all possible, we would recommend having the same individual teaching all of the workshops so that the material is delivered in a consistent and uniform fashion. The instructor would have to be compensated, which would be funded by the college. Ultimately, the cost of compensating someone is minimal, and should not be an issue in moving these workshops forward.

Costs

Since these workshops are targeted towards students in particular to increase their knowledge of fixing and maintaining their bikes, we would like to offer this course at no cost. The workshops would also be offered free of charge to all employees of Dartmouth College. Individuals outside of the college are encouraged to attend these workshops, but we would suggest charging a minimal fee of less than \$5 for each session. We also suggest that certain bike parts would be for sale at these workshops, such as bike chains, tires, inner tubes, chain lube, etc. and could be paid for with Da\$h or cash. That way, new parts are accessible to students, and they will learn to install them onto their bikes. Another expense that may arise from these workshops is the need to provide tools to attendees. Thus, an adequate amount of tools would have to be purchased that are the same types that are at the bike repair stands so students can learn how to use them correctly and in what situations to use each tool. The only remaining cost would be paying the instructor (a minimal cost), and to pay for the parts that the instructor would be utilizing, since they would be using their own bike theoretically.

Bike Repair Stands

One reason that we believe these bike maintenance workshops will be extremely effective in terms of education is that it ties in well with some of the implementation plans suggested by the Engineering group. One of their suggestions is to implement a series of tool stands, where students can make minor repairs to their bikes. However useful these stands may be, they will be a waste of investments and space if students do not know how to utilize them. For this reason, the workshops will be a very effective way for students to learn how to use the tools correctly in order to fix or repair any bike issues they may come across.

Lesson Plans/Curriculum

Introductory Bike Workshop

As this workshop is aimed towards incoming freshmen and those who have little to no experience with repairing/fixing bikes, this workshop will be very basic. Some of the key components that we would recommend to this course in addition to what the instructor deems relevant would be as follows.

- Conducting a pre-ride safety inspection: The instructor will demonstrate how to conduct a safety inspection on the individual's bike by teaching how to make sure...
 - The tires are adequately inflated
 - Checking to see if the tire rubber might be cracked, gouged or worn
 - Making sure the brakes function properly
 - Adjusting the seat to the appropriate height
 - Check that the chain turns cleanly through front and rear sprockets while not rubbing against the derailleurs
 - Checking that (if using a multiple geared/speed bike), the bike shifts gears properly
- How to remove wheels
- How to change tires
- Proper cleaning and lubrication of mechanical parts/components
- Basic safety procedures such as signaling, keeping appropriate distances from cars, and sharing the road
- Basic bike component terminology overview
- Q&A at the end of the session

Bike Maintenance Workshop

As this workshop is aimed at participants who have already attended the "Introductory Bike Workshop," this workshop will cover more technical repair/maintenance that requires some background knowledge. Some of the key components that we recommend for this course, in addition to what the instructor deems relevant, would be as follows.

- Flat tire repairs, patches, and replacement
- Drivetrain basics
- Gears, shifters, brakes: how to replace, determine what is wrong, and when to replace
- Wheel truing
- Introduction to hubs, bearing surfaces, and headsets
- Introduction to bottom brackets and crank sets
- Q&A

Future implications

Should these workshops prove to be very effective, popular, and beneficial to students, faculty, and staff, there is a great deal of potential for expanding the program. One idea for the future is making the workshops more specialized. One way to do this is to split up what kinds of bikes are being repaired. Some people may choose to purchase mountain bikes, while others may be more inclined to purchase a road bike for racing. Since there are differences in the two types of bikes, and the types of repairs/maintenance that they require, it might be helpful to implement two separate courses in the future, one for each type of bicycle. Furthermore, if students become well versed enough in repairs/maintenance after taking this course, it might be possible to offer a sort of certification program. A certificate of repair may be offered to those individuals who are deemed adequate enough by the workshop instructor to fix bikes. These individuals, if chosen, would have the opportunity to have their names posted to the biking website where students could contact them to repair their bikes for a standardized hourly rate + parts.

Advertising

In order for these bike maintenance workshops to be successful both in the short and long run, it is necessary to implement a strong advertising campaign. As such, we recommend several initiatives to make students, faculty, and staff aware of these workshops. The first mode of advertising would be to place advertisements for the workshops in places that are associated with bikes. This would include, but would not be limited to, advertisements at the bike repair stands, ads attached to bike racks, ads near the Collis bike pump, and more. Also, since one of the most important target groups of this portion of the program are freshman, the introductory workshop would be heavily promoted during first year orientation and detailed information about the workshops would be distributed to first year students by means of a pamphlet, postcard, etc. It is also relatively cheap to print small postcards with info about the workshops and distribute them in students' Hinman Boxes. This would be extremely effective as students constantly check their Hinman Boxes and would undoubtedly see these post cards. Another way to effectively disseminate information about the workshops is via listsery. Since Dartmouth utilizes "Blitz" so heavily, sending out blitzes about the workshops via campus events listsery, cycling club listsery, DOC listserv, and many others would make for a cost free and quick way to inform people about them. Finally, simple promotional acts like using sidewalk chalk, hanging up posters in Collis, or

even spreading info via word of mouth could be useful. However, we believe that the most effective means of advertising the workshops will be to have clear and concise ads at bike repair stands and bike racks, and sending postcards via Hinman. Finally, all information about the workshops would be made available on the biking website we have proposed under the "First Year Page" as well as the "maintenance" page.

PE Class

Bicycling classes such as the one proposed are something that would be new to Dartmouth College, but they are not new to many other schools. The University of Minnesota, which earned a gold in the Bike Friendly University Assessment, offers varying classes once a week. Many of the classes such as U-Cycle 101 ensure that students have the tools necessary to bike safely and comfortably on their campus, while others such as the "Beginner Unicycle Clinic" are just to inspire a fun spirit of biking around campus (University of Minnesota).

Therefore, along with the website, another recommendation of the bicycling education section will be a physical education (PE) class run through the sports department at the college. Based on the results of the survey, 26% of all student respondents would be interested in taking a PE class that focused on: bike maintenance, easy and safe routes to ride around campus/the upper valley, and bike safety. Although 26% of respondents may seem like a low number of students who are interested, when broken down this equates to approximately 100 students who would like to take the class. Considering only a fraction of all students at the college responded to the survey, and that this PE class would be capped at a low number of students (around 10), the future projection for interest in this class is very high.

We believe that having a face-to-face PE class will:

- Increase overall campus education on biking safety and maintenance
- Increase students' confidence so that they will feel more comfortable biking
- Promote the "bike-friendly" culture we are trying to achieve at the college
- Help close the gap between biking for fitness versus biking for commuting
- Decrease bike waste, by increasing awareness
- · Give students real world biking skills that carry over outside of college

Curriculum wise, we plan to create a course based off the principles and skills taught in selected League of American Bicyclists' Ride Smart Classes. The classes that we are currently planning to model are: Traffic Skills 101, Traffic Skills 201, Group Riding, Commuting, and Safe Routes to School. The descriptions of each of these classes can be found here (http://bikeleague.org/content/take-class). The classes we chose to omit are primarily focused on teaching child bicyclists, and would not be necessary or conducive for the purposes of this PE class. The League of American Bicyclists offers certification to teach these classes, and we

would seek to find a current community member or faculty member who is comfortable going through the certification process and teaching the class. We would also recruit several "TAs" to ensure that attention is given to all students in the class, which would assure safety when doing activities such as group rides.

Curriculum

The idea is to base the curriculum off of the skills and ideas presented in the selected League of American Bicyclists' Ride Smart Classes. In conjunction with the skills outlined below, there will also be a once a week component where the class will go on "practice rides" to learn the safest routes to travel when riding around campus and the upper valley. On this day the selected TA's will join the class to ensure that every rider and all levels of riders are accounted for. Outlined below are the central ideas in the classes offered by the League of American Bicyclists:

- Traffic Skills 101
 - Learn to ride safely and legally in traffic or on the trail.
 - Learn how to conduct bicycle safety checks, fix a flat, on-bike skills and crash avoidance techniques.
- Traffic Skills 201
 - Learn about fitness and physiology, training for long rides, advanced mechanics, pace line skills, advanced traffic negotiation and all-weather riding.
- Commuting
 - This Follow-up class to TS101 covers topics including route selection, dealing with cargo and clothing, bike parking, lighting, reflection, and all-weather riding.¹⁰⁰

In the first Unit of the class (most likely the first few weeks of class), the topics that will be covered will mirror those in Traffic Skills 101. Then, once the basics of riding on the road are covered, the once weekly practice ride will begin. In later weeks there will be a blend of the topics outlined in Traffic Skills 201 and Commuting based on student need and interest. If more

¹⁰⁰ "Our Classes." . League of American Bicylicsts, 15 Nov. 2013. Web. 30 Apr. 2014. http://bikeleague.org/content/take-class-

students are interested in using their bike for commuting there will be more practice rides and routes to areas outside the Dartmouth campus. If students are more interested in the fitness and physiology aspect of biking, there will be more long rides and routes that would be good for fitness biking.

Costs

The possible costs for this class would be divided into upfront and ongoing costs. The upfront costs will be the most expensive, because around 10 to 15 bikes would need to be purchased before the PE class can commence. Another upfront cost will be the cost of getting an instructor certified by the League of American Bicyclists. While these costs are rather expensive, the ongoing costs of the PE class are very reasonable, and eventually the class could become economically self-sustaining. The ongoing costs include compensation for the instructor and the TA's, maintenance on the PE bike fleet, and possibly the cost for reserving a space for the class. The average price for a PE class ranges from \$50-\$120 per class, therefore providing capital for the ongoing costs of the class.

Advertising and Promotion

One great incentive that will insure the success of the class is the requirement for all Dartmouth students to have at least three PE credits upon graduation. By offering a PE credit for this class, it will attract a diverse group of students from all corners of campus. In addition to the offer of a PE credit, we propose that flyers and email are the next best ways to promote and advertise this class. While it would be added to the roster of PE classes, emailing to the campus, and posting flyers at major campus hubs will give the class more visibility. Also by emailing out and posting flyers, the students can gain more information on the class, so that we can ensure the students who sign up are taking the class because they are interested in the subject matter.

Bicycle Rental Educational Component

Current Bike Rental Program

The Dartmouth College Sustainability Office refurbishes abandoned bikes around campus and rents the refurbished bikes to students for \$25 per bike per term. Although the program only distributes roughly 10 bikes per term, students enjoy the service and look forward to its expansion. As the Sustainability Office collects more abandoned bikes, the program will gradually expand until the program satisfies campus demand.

Additional Education Component

In addition to the \$25 termly fee, we recommend that the renting students attend or commit to attending at least one Maintenance Workshop or the Biking Physical Education Course in order to obtain eligibility to rent a Sustainability Office bike. However, this education component would only apply once during a student's four years at Dartmouth rather than every term a student uses the program. By creating an educational component to the already successful and highly demanded bike rental program, Dartmouth students enhance their skills to maintain their bikes, boost their biking and maintenance confidence and gain abilities to contribute to the overall biking culture, ultimately fostering a more bike friendly campus. Furthermore, the additional education component will encourage non-cyclists to start biking since the PE course teaches beginning biking skills and makes non-riders enthusiastic about their new ability to ride. These new cyclists can use the biking program instead of purchasing their own bicycle.

Advertising

This program should be advertised on the website, particularly on the first year page so that students are aware of the program from the beginning of their Dartmouth career. The program should be advertised at the Sustainable Moving Sale during orientation at the beginning of the fall and sent to first year families during the spring first year mailing and first year graduate students with their informational packet. Both these methods will allow incoming freshmen, their families and new graduate students to decide the best biking plan, renting or buying, for their unique situations before the hectic Dartmouth lifestyle begins and dorm and apartment shopping period commences. Since the educational component requires either a maintenance workshop or the PE course, this program can also get advertised alongside these two program's advertising schemes. Additionally, the website will contain all biking related programming so the website will already contain the details about the Sustainability Office's rental plan. The Sustainability Office should also include the educational component on all current rental program advertising and the beginning termly blitz that gives Dartmouth community members bike programming updates (see Website Advertising section above).

Education Conclusion

In Conclusion, the education sub-section believes that in order to make Dartmouth a more Bike Friendly environment, resources for bike safety, maintenance, and skills need to be easily accessible. This is why the first priority should be to update the currently existing Bike Website with interactive biking routes, a first year student page, a bike forum, and instructional videos. Advertisement for the website is also essential, since in the past Dartmouth had already created and used a biking web pages and websites that resulted as unsuccessful. However, with the help of catchy advertising and the sustainable office's support, this new biking webpage could turn out to be a success.

Not only do we support a website for available information, we also support educational workshops where students can either take introductory maintenance courses their freshman year or in other classes in the rest of the year for returning students. So the maintenance workshops will be hands-on and there will also be informational videos available on the biking website. A Physical Education class option would be a collaborative program with Dartmouth's sports department so that such a course could help increase the overall campus education in bike safety. It would help increase students' awareness in skills while also providing physical fitness. The next step is to help Dartmouth campus to adapt physically so that students who are aware of bike safety and skills can actually make use them in a more welcoming environment. Therefore, the engineering is an important consideration to actually implement these encouraging, educating ideas into a more tangible bike-friendly campus. The engineering section of our proposal will speak more about the current infrastructure that need to be changed in order to achieve our future goals.

Part 3: Engineering

Engineering Introduction

In order to become a Bike Friendly University (BFU), Dartmouth College needs to improve and increase biking infrastructure around campus. According to the BFU application, campuses should have end-of-trip facilities, bike parking structures, and campus paths and shared-road networks to provide safe and easy transportation for cyclists.¹⁰¹ This section summarizes the current state of biking infrastructure at Dartmouth, describes its problems and shortcomings, and prescribes solutions to make Dartmouth a more bike-friendly campus. Currently, Dartmouth's biking infrastructure includes of underutilized and ineffective bike racks, limited bike storage in the basement of dorms, and infrequent pop-up maintenance bike shops, just to name a few. Additionally, the campus' roads and pathways also have limited bike signage with no clear indication of where cyclists should ride through the College. Our goal is to suggest solutions that will facilitate easy bike transport to and through Dartmouth's campus by examining roads, intersections, and paths around Dartmouth's campus, analyzing both short-term bike parking and long-term storage options, and improving the accessibility of bike maintenance resources for students and staff.

¹⁰¹ League of American Bicyclists Website

Transportation

This section prescribes infrastructure suggestions for roads, paths, and intersections on Dartmouth's campus. In the survey conducted by our class, of those who self-identified as frequent cyclists 44% reported biking on sidewalks while 50% reported biking on streets.¹⁰² It is clear that there is confusion surrounding where cyclists should ride, and this confusion contributes to congestion and hazardous conditions for both pedestrians and cyclists. In the same survey, 41% (92 people) noted that they would prefer to bike on a specified bike lane on the road, followed by a specified bike land on the sidewalk (21% of respondents, or 48 people). These survey results prove that we need to improve bike transportation infrastructure within Dartmouth's campus and provide infrastructure guidance for campus cyclists.

Table of Potential Solution Descriptions

Note: for all paint-related improvements, we recommend green paint, which will fit Dartmouth's traditional color scheme and appear unobtrusive amongst the landscaping.

Infrastructure	Description	Advantages	Problems
<section-header><section-header></section-header></section-header>	This type of improvement is a colored stripe approximately 3ft. wide painted on the road's shoulder that is an added lane to separate cyclists for automobile traffic.	 Separates cyclist from vehicle traffic and makes the road safer for cyclists Designates a path for cyclists, decreasing confusion of where to travel 	- Requires road widening to make space for the painted lanes - Right of way problem - Obstacles to zoning approval

102 ENVS 50 Survey

		- Shows	
		prioritization	
		biking as a	
		mode of	
		transport	
		- Traffic	
		calming,	
		making the	
		road safer for	
		cyclists	- Potential
Painted Rika Shoulders		- Provides a	negative
		designated	aesthetic
	Painted road	path for	- Annual
	shoulders, of	cyclists	renainting
+	whatever width is	- Drivers	required
	currently available	inclined to pay	- Obstacles
		more attention	to zoning
		to staying	approval
		within their	upprovur
		lanes	
		- Visual	
		reminder to	
		share the road	
Shared Bike Lane Arrows	Painted bike	- Make drivers	
"Sharrows"	symbols on the	and cyclists	
	road indicating to	aware that they	- Obstacles
	drivers, cyclists,	are sharing the	to zoning
	and pedestrians	road, the road	approval
	that the road is	becomes safer	TT
	being shared.	because	
	These sharrows	drivers are	

	could be placed	more cautious	
	on car lanes, bike	- Subtly	
	lanes, road	indicates a	
	shoulders, and any	path for biking	
	shared use paths.	- Does not	
		require	
		structural	
		change of road	
		- Cyclists and	- Strict
	Widened	pedestrians	sidewalk
Shared Use Daths	sidewalks that	both have	width
Snared Use Paths	allow for	designated	regulations
	pedestrians and	path to travel	of five feet
SI SI	cyclists to travel	on	- Large
	simultaneously	- Multi-use	structural
	and are usually	infrastructure	change of
	divided into two	- Eliminates	sidewalk
	lanes to allow for	the danger of	- Obstacles
	two-way traffic.	cyclists in	to zoning
		vehicle traffic	approval
	A single lane	- Makes the	- Large
Piles Suggestion Lanes	automobile road	road more	structural
Dike Suggestion Lanes	flanked by two	equally shared	and traffic
	bike lanes. Here,	between the	flow change
	two cars passing	driver and	to the road
	each other could	cyclist	- Obstacles
	move into the bike	- Calms traffic	to zoning
	lane, but bikes	- Gives	approval
	have the right-of-	cyclists	- Transitions
	way. This	confidence to	between
	infrastructure	hike in the	these roads

	implementation is	street because	and
	for streets with	of right-of-	traditional
	lower levels of	way	roads
	traffic		
Speed Tables		- Slows traffic	-
		to make the	Exaggerates
		road safer for	the actual
	Raised portions of	cyclist and	safety of
	roads that force	pedestrian	crossing,
	drivers to slow	crossing	may cause
		- Guide for	reduced
		best place to	pedestrian
		cross road	caution
Bike Route Wayfinding Signage	Bike route signs will guide cyclists through campus, indicating where they can bike safely. These eye- level signs will help separate bikes from pedestrians and car traffic.	Bike route signs can be incredibly effective if they include directions and destinations. For example, one bike sign can say "Bike Route to LSC."	-Cost of installation

General Suggestions

Install Bike Route Wayfinding Signage¹⁰³

- These bike route signs should be placed every 300 feet, most importantly at big intersections.
- Specifically, bike route signs can be used to indicate routes other to travel to specific destinations. In the North end of campus, bike route signs can be used to indicate a path from behind Baker Berry Library, past Sudikoff Lab, through the McLaughlin Cluster to the LSC. The Bike route signs, combined with a green stripe indicating bike paths will easily distinguish road space for pedestrians versus cyclists.

Improving Intersections

Intersections are tricky areas at Dartmouth because cyclists usually take the most direct route, and often ignore traffic rules. Exacerbated by fading or missing road signage, intersections are high-risk areas for collisions between cyclists and pedestrians.

Use Shared Lane Markings, or Sharrows, at Intersections¹⁰⁴

Sharrows are visual markers indicating that a certain section of the street is designated for cyclists. Sharrows combined with a colored green bike lane at intersections would provide a clear pathway for cyclists and could potentially decrease pedestrian and biker collisions.

Protected Intersections

Nick Falbo, a Portland based planner, has established guidelines to creating "protected intersections."¹⁰⁵ Protected intersections require four things: a corner refuge island, a forward stop bar for bicycles, a setback bike and pedestrian crossing, and bicycle friendly signals. For the purposes of Dartmouth's campus, a corner bike refuge would be the most useful at busy intersections like the ones pictured above. Corner bike refuges "physically separate bicyclists as they make right turns, and provide a secure refuge for those waiting" to turn.

¹⁰³ NACTO Website

¹⁰⁴ Ibid.

¹⁰⁵ Bicyclemobile.org Website



Corner Bike Refuges



Speed tables

Speed tables slow down traffic and make drivers more aware of pedestrians and cyclists crossing the road.¹⁰⁶ Speed tables, like the one in front of McLaughlin, should be installed in more highly trafficked areas to slow traffic and facilitate bike transportation.

The Dartmouth Green is one of Dartmouth and the town of Hanover's most iconic physical attributes. However, in terms of biking, the entire Green and each of the four surrounding streets are problem areas. The setup of this infrastructure is not conducive to biking. One subject commented that she both prefers and always does bike on the streets because biking crowds the sidewalks and cyclists are meant to travel on the street with cars. She noted, though, that on the strip of Wheelock Street adjacent to the Green, she reverts to biking on the sidewalk because the street is too congested, flanked by two very dangerous and risky intersections, and she does not feel comfortable riding behind the row of parked cars in case one happens to come zipping out unexpectedly.¹⁰⁷ There is also a bottleneck between West and East Wheelock Street at the intersection in front of the Hopkins Center.¹⁰⁸ This causes even more volume of traffic on the road going from a wider road to a narrower one, with buses stopping and pulling out from the curb, and people crossing the street every which way. These aspects create a problematic biking area because the legal way cyclists should behave is confusing and dangerous. In order to get around this, people ride on the sidewalk or tentatively on the street. Also, some people choose to push their bike on the sidewalk on this segment or avoid it entirely by choosing an alternate route, which is inconvenient.

¹⁰⁶ Traffic Calming Measures

¹⁰⁷ Leger

¹⁰⁸ Whitcomb
South Side of Green—East Wheelock Street

- Very little room for a bike lane, but coloring the shoulder on the south side of the street would slow traffic and give cyclists on at least one side of the street a more secluded place to ride
- According to Joanna Whitcomb, Director of Campus Planning, the area in front of the Hopkins Center and Hanover Inn is subject to renovation and this presents an opportunity to add bike infrastructure in the form of a turning refuge at the College St. intersection, designated bike lane on the road, and improved street markings to make turning and right-of-ways clear¹⁰⁹
- Sharrows should be added on both sides of the street
- A colored speed table through the pedestrian refuge
- Increase presence and frequency of bike route signage



Along the eastern side of the Green, there is another slew of potential implementations to benefit cyclists. This side of the Green is a problem area because there is an undefined double lane, which causes some cars to pass others in a potentially dangerous way. For example, there is a high flow of foot traffic at the crosswalks. When one car stops for pedestrians, another may not and just speed by, putting the pedestrians at great risk. The double lane allows cars to experience a separate left turn lane and a proceed-straight lane. The undefined nature of the double lane road

¹⁰⁹ Ibid

makes this segment of street very hectic and less safe for a cyclist as the road has more commotion and no defined shoulders. There is also a sidewalk on the East side of the street and a path on the west side that is on the Green, neither of which are bike friendly. This is the first leg of one-way streets around the Green and is therefore an important way for cyclists traveling on the roadway, which is the most appropriate place for one to bike. In order to proceed down this leg of the Green, the cyclist bikes unsafely on the wrong or crowds the sidewalk or path on either side of the road.

East Side of Green—College Street

- Suggestion lane to allow cyclists to fully share road
- Painted bike lane: Joanna Whitcomb mentioned that the idea had been proposed to consolidate this double lane one-way street into one lane to decrease the danger for drivers and pedestrians, and to decrease traffic frenzy and confusion.¹¹⁰ In addition, with the extra road space, a bike lane could be added to either the west or east side of the street. This way it could continue around the entire Green in the same one-way nature as the road, and allow cyclists to avoid riding on sidewalks or across the Green. This lane would ideally be extrapolated to the north and west sides of the Green, where the street lanes would also be condensed into one (Wentworth Street) or two (North Main Street) lanes with an added bike lane. As Whitcomb mentioned, because of the removable nature of paint it is possible to test this implementation of a bike lane on these three sides of the Green.¹¹¹ Whether the bike lane is designated on the East or West side of the road would be left to the discretion of the Office of Campus Planning
- Replace current crosswalks with colored speed tables
- Sharrows on road and potential bike lanes, if implemented
- Increase bike route signage

¹¹⁰ Ibid

¹¹¹ Ibid



Similar to the east side of the Green, the north end on Wentworth Street has the same issue of an ambiguous and undefined double lane branching into two separate lanes approaching the intersection into North Main Street to turn either right or left. There is no crosswalk bisecting this street, however there is one on each end connecting Baker-Berry's plot of land with the northern corners of the Green. Thus, this street is seemingly less of a dilemma in terms of traffic-pedestrian interactions and dangers, although people tend to cross freely throughout the entire length of the street. Still, some sort of bike transport infrastructure is necessary as the actual street is crowded with vehicles and the sidewalk is crowded with people. In this area, cyclists tend to bike on the sidewalk at the foot end of Baker Lawn as it is relatively broad.

North Side of Green—Wentworth Street

- Suggestion lanes
- Or continued painted bike lane as proposed for College Street, with a single defined auto lane
- Sharrows on street and/or on potential bike lane, if implemented
- Speed tables at both ends of the road through intersections (not as effective as those that bisect streets in terms of controlling car speed)
- Increase bike route signage

Lastly, the west side of the Green on North Main Street is a problem area because of the hectic nature of road design. It is again a one-way street that has unmarked lanes that split into three distinct lanes approaching the Wheelock intersection. Two crosswalks bisect this road connecting Administration Row with the Green, both or which are dangerous with the influx of cars coming around the Green and from the north end of campus. There is also rampant "j-walking" across the three lanes approaching the intersection as people, typically students, move from the Green to Collis and vice versa, but do not want to wait for the light. This stretch of North Main Street is extremely crowded with moving cars and people, and poses a dangerous situation for cyclists, especially having three undefined lanes. Also, there are cyclists who do not want to bike on the sidewalk due to foot traffic¹¹², but also do not want to ride all the way around the Green and thus choose to bike the wrong way (north) on the street, a very dangerous practice. The west side of the Green is a huge problem area for cyclists leading into an even bigger problem area in the Wheelock intersection. The following are a few proposed solutions.

West Side of Green—North Main Street

- Define auto lanes
- Continue painted bike lane as proposed for College and Wentworth Streets
- Sharrows on street and on bike lane, if implemented—these sharrows should continue further north up North Main Street
- Painted shoulders on segment of North Main Street that is north of the Green
- Replace both crosswalks that bisect street with colored speed tables
- Bike refuge at intersection
- Increased bike route signage

College Street to LSC

Many cyclists bike on the west sidewalk that leads continuously to the LSC and back to campus, rather than on the road. This sidewalk frequently has high pedestrian traffic and it becomes dangerous when cyclists are also traversing along the same path.

¹¹² Leger

Convert Dirt Path on the East

• Moving north along College Street to LSC, there is a little dirt path on the right side of the street that can be converted into a more robust bike path to eliminate bike traffic from the left sidewalk. Bike signs that clearly label this path will divert bike traffic from the left side of the street to the right. In order for this to be successful, the intersection of College and Maynard St. should have a green bike lane and bike route signs that clearly show a way for cyclists to get on to the bike path. A bike path leading from the right side of the road to the entrance of the LSC is needed to facilitate bike movement from the path to the entrance of the LSC. Here, a cyclist/pedestrian refuge, like that on East Wheelock St in front of the Hopkins Center and the Hanover Inn, would be very helpful for the cyclist to travel across College St to get to LSC as the ideal crossing point occurs where there is a bend in the road, making it even more difficult to cross with the high-volume traffic. Similarly, a painted speed table could be implemented here to facilitate crossing the street as well as to slow down the traffic driving onto campus, which would make the road safer in general.



Paint the Road Shoulders Green

 Another suggestion for College Street, similar to other streets around Dartmouth, is to paint the road shoulders green. In Ithaca, New York, officials undertook a "shoulder tinting research project."¹¹³ This project painted road shoulders green in an attempt to slow down traffic, divide bicyclists and pedestrians from car traffic, and generally

¹¹³ The Post Standard

organize the road. Dartmouth should institute its own research project on shoulder tinting. The picture below is Ellis Hallow Road, in Ithaca, after being painted:



Massachusetts Row

Students use this path to travel from Collis, Class of 1953 Commons, and Robinson Hall to the Massachusetts Dorms, Thayer, and other northern campus buildings. Since no cars can travel through this roach, it is a great opportunity for cyclists to cut quickly through campus.

Suggestion Bike Lanes and Paint Sharrows

• A suggestion bike lane on this road, and sharrows indicating where cyclists should bike would fully utilize this road and make it an attractive option for cyclists looking to cut through campus. The suggestive bike lane is most effective on streets where there is no yellow divider. The white suggestive paint shows that there is a path for cyclists and will separate bikers from pedestrians.¹¹⁴



¹¹⁴ NACTO Website: Suggestion Bike Lanes

Replace Automobile Barriers

• Currently, cars are kept off of Massachusetts row by a wire strung between two pillars. This poses a significant threat to cyclists, as the wire is difficult to see. Replacing these two immobile pillars with a single one placed in the middle of the road, which can be retracted into the ground, will reduce the risk to cyclists and still exclude cars from this section of campus

Tuck Drive

Tuck Drive is currently very wide and provides a safe transit route for cyclists. However, the width can be better utilized by painting sharrows and suggestion bike lanes.

Paint Sharrows and Suggestive Bike Lanes

We suggest adding sharrows to this road to make clear to cyclists that they should be biking on the street as opposed to the sidewalk. Also bike lanes would be ideal on this road because there is currently no yellow road divider, so cars can move into the lanes if there are no cyclists. However, when cyclists are present, bike lanes will separate them from the traffic in the middle of the road and provide visible guidance.



Thayer Drive

Thayer Drive is currently very unsafe for both pedestrians and cyclists. There is no road shoulder or sidewalk separating pedestrians and bikers from cars.

Add Sidewalks

Paving sidewalks on both sides of Thayer Drive would provide a safe passageway for people and cyclists. Specifically, if these pathways were shared use pathways then bikes can have their separate lane from walkers. Also, adding sharrows on this segment of road would make it safer by making drivers more aware that they are sharing the road.

West Wheelock Street:

West Wheelock is a very dangerous street for both cyclists and pedestrians. There are limited cross walks and cars drive quickly up and down the street until they approach the Main St intersection.

Painted Bike Shoulders and Sharrows

 Painted bike shoulders would not only slow down traffic, but would also provide a visual separation for cyclists and vehicles. Sharrows on the bike shoulders would indicate to cars that cyclists would be biking alongside the road. Also, a few speed tables or even low speed bumps starting at the New Hampshire side of Ledyard bridge going up West Wheelock St to the intersection with Main St would slow down traffic to make the road safer for biking, along with adding in more potential crossing sites.



Speed Table

• A speed table should be placed at the intersection of Thayer Drive and West Wheelock. This intersection is very dangerous for pedestrians and bikes. Cars speed up West Wheelock and people frantically try to cross the road at scattered points. A speed table, like the one outside of the McLaughlin Cluster, would reduce traffic speed and increase the likelihood that vehicles would yield to pedestrians and cyclists.¹¹⁵



The east side of campus presents another huge problem area in terms of biking at Dartmouth. The major infrastructure in this section of campus is sports related infrastructure and housing. Almost 25% of undergraduate students play on a varsity team, meaning they travel to the Floren Varsity House and the field area frequently.¹¹⁶ Much of the rest of the student body and faculty use Alumni gym, which is also located on this side of campus. And yet another portion of the Dartmouth and Hanover communities travel to the coop and beyond. If accessible, many students drive to the coop to buy food because it is relatively far compared to other Hanover locations, and carrying groceries for a twenty minute walk up the hill is less than ideal. Thus, biking is a viable option, but biking on East Wheelock Street and South Park Street are

¹¹⁵ Institute of Transportation Engineers

¹¹⁶ U.S. News & World Report: Dartmouth College

very busy roads with high volume vehicle traffic. South Park Street already has a designated bike lane on its shoulder, which is an example of good bike infrastructure in the area.

East Side of Campus—South Park Street

- Painted bike lane: the designated bike lane could be painted green to distinguish it even more from the actual road and increase bike safety. Paint is generally low cost and the effort of labor necessary is typically low as well
- Bike lane dividers to further segregate the bike lane from the automobile lane and make biking safer for the cyclist¹¹⁷
- Increase bike route signage

The other major problem area on the east side of campus that is a major connector to the athletic facilities, athletic fields and coop, amongst other common destinations is East Wheelock Street. This street is a majorly used roadway in Hanover, going right through the town, and burdens large traffic volume. The street is also relatively narrow for such a frequently used roadway and its south side is lined with parallel parking spots for cars, which makes biking on this street even more dangerous and narrow, taking away the streets southern shoulder. East Wheelock Street meets South Park Street at a four-way intersection that has relatively high flows of traffic and can be dangerous for a cyclist to travel through. Many cyclists ride on the sidewalk on this street, as well as the fact that it is on an incline. The incline increases speed of cyclists, which increases the danger of walker-cyclists interaction. Other cyclists ride on the road but risk danger from lack of street shoulder and from riding past parked cars that could pull out or open a door at an unexpected time.

East Side of Campus—East Wheelock Street

• Paint shoulders of street: East Wheelock Street has parking on the north side of the street along the Green and on the south side of the street from Wilson Hall all the way until the intersection with South Park Street. Thus, the shoulder on the north side of the street for this area could be painted for cyclists

¹¹⁷ Inhabitat: Bike Lane Dividers



• An alternate bike route: because East Wheelock Street is narrow and difficult to change, an alternate route (see map) for a bike path would be easier. This path could go from the Hopkins Center, continue on the path between Wilson Hall and New Hampshire Hall into the New Hampshire Lot behind the building and into the Vox Lane Lot, onto Crosby Street for about fifty yards and into the Gym Lot between the back of Alumni Gym and the football stadium. This path would branch, continuing straight through to connect to the South Park Street bike lane and turning right to meander between Floren Varsity House and the baseball stadium, all the way to the crosswalk bisecting South Park Street leading into the field area. This bike path would be painted green to highlight the route and segregate it from the actual roads and lots that it travels on. It would also be accompanied by signage designating it as a bike route



- Sharrows on East Wheelock Street and alternate bike route, if implemented
- A colored speed table bisecting the street at the Crosby Street intersection
- Increased bike route signage



Short-Term Parking

One of the most visible and important aspects of the biking infrastructure at Dartmouth is the availability and style of short-term storage, or parking. This section describes different bike parking structures, summarizes Dartmouth's current parking infrastructure, provide an analysis of why it is or is not working, and present our proposed changes to the parking infrastructure. According to the Bicycle Coalition of Greater Philadelphia, bike racks should meet five criteria. Bike racks should:

- 1. Support the bicycle upright by its frame in two places
- 2. Prevent the wheel of the bicycle from tipping over
- 3. Enable the frame and one or both wheels to be secured
- 4. Support bicycles without a diamond-shaped frame with a horizontal top tube
- 5. Allow both front-in and back-in parking so that a U-lock can lock the wheel and a vertical tube of the bicycle¹¹⁸

Feature	Cost ¹¹⁹
Inverted 'U'	\$99 - \$250 / rack ; \$250 - \$400/ set of 4 racks
'A' Rack	\$99 - \$250 / rack ; \$250 - \$400/ set of 4 racks
Post and Loop	\$130 - \$250/ rack
Coat Hanger	Unknown
Comb Rack	\$200 - \$300/ rack
Wave Rack	\$100 - \$200/ rack
Rack Covering	Unknown

¹¹⁸ Bike Parking Racks Fact Sheet

¹¹⁹ Outdoor Bike Racks

Of these common forms, only the Inverted 'U,' 'A,' Post and Loop (P&L) and Coat Hanger racks meet the above 5 criteria. However, the majority of Dartmouth's bike parking consists of Wave Racks. These, as well as Comb and Toast, are wheel-bending racks, which support the bike by its tire instead of the frame. This will cause the wheel to warp when left for too long or when pressure is applied to the bike. An interview with the Sustainable Bike Interns, who work through Dartmouth's Office of Sustainability, revealed that this is a common occurrence for bikes left on Dartmouth's racks for extended periods of time, particularly over winter break and Winter Term.



Other Bike Friendly designated universities use a variety of bike rack designs. Stanford University, which has a platinum ranking, uses lightning-bolt racks¹²⁰. The University of Minnesota uses many coat-hanger racks to maximize space efficiency, and they are located at nearly every building¹²¹. These campuses, and many of the other BFU-certified schools¹²², also designate parking areas that are separated from pedestrian and automobile traffic in order to avoid congestion. By providing easy-to-use and convenient parking that fits into the students' pre-existing habits these schools encourage proper use of the facilities.

Our campus survey revealed that many students at Dartmouth find parking to be a factor in their decisions to ride a bike, or not, around campus. The responses shed some light on worthwhile improvements of parking infrastructure for Dartmouth. Of our survey respondents that identify as frequent bike users:

¹²⁰ Stanford Campus Site Furnishing Guidelines

 ¹²¹ Bicycle Parking
¹²² Current Bicycle Friendly Universities Spring 2013

- 14% have in the past chosen to not ride because "locking up, maintaining, and storing a bike is too much of a hassle"
- More than 60% use bikes for local transportation (Dartmouth's campus and Hanover)
- 54% won't bike because of weather and road conditions

Among the respondents that bike rarely:

- 44% said it is because they find it more convenient to drive or walk
- 21% said that parking their bike is a hassle

Finally, of those that do not have a bike on campus:

- Nearly half (47%) find it more convenient to drive or walk
- 67% have at some point used a bike to move around Dartmouth's campus or Hanover.

These findings indicate several leverage points with which to improve parking infrastructure. The high percentages of users that use bikes mainly for local transport show a need for plentiful and conveniently placed parking. Similarly, a significant number of users found other modes of transportation to be more convenient than biking. Improved parking structures are one aspect of many that will make biking more convenient, and therefore more attractive to Dartmouth-affiliated individuals. This data supports anecdotal evidence of inconveniently placed, overcrowded and poorly designed parking.

With this data and feedback in mind, we make the following general recommendations for Dartmouth's entire bike parking structures, and should be applied to all below recommendations regardless of whether explicitly stated:

- Replace all wheel-supporting racks with frame-supporting structures such as 'A,' P&L, or Coat Hanger. Bikes are more likely to fall over, take up unnecessary space and warp when supported only by a front wheel.
- 2. Provide weather covering for all parking locations so that students can use their bikes on days when it might rain without fear of ruining the bike.

In areas that do not have space for full racks, but still require more bike parking, an addition of a loop or ring to parking meters is a cost and space-effective way to provide more bike parking. P&L racks can also serve this purpose.

Below are outlined a non-exhaustive list of the most problematic areas for bike parking around campus, and our recommendations for how they might be ameliorated.

Front of Class of 1953 Commons

- Remove the benches at the front and replace with 'A' or P&L racks perpendicular to the front of the building
- Convert the concrete patch at the bottom of the wheelchair-accessible ramp to bicycle parking, with several rows of 'A' or Coat Hanger racks





Collis porch & left side of Robinson Hall

- Replace current Wave racks with a row of 'A' racks covered by an overhang coming off of Robinson Hall's wall
- Add cement paths on either side of the main Collis porch stairs to accommodate a row of 'A' racks with a low cover

Front and back of Robinson Hall

- Front: Level the land on the right of the steps (the side without the DOC sign) and replace current Comb racks with a small parking lot of 'A' racks.
- Back: Replace Wave rack at the top of the basement steps with 2 rows of 'A' racks

Patio between Robinson Hall and Collis

- Replace racks by landfill and recycling bins with a row of covered Coat Hanger racks
- Improve the 'Free Air' station, which is currently difficult to use and access because of its location behind tables and bike racks
- Include maintenance station
- Replace Comb behind poster kiosk with Coat Hanger rack

Front of the Hopkins Center

- Run a student contest to design an artful bike rack to be placed in front of the glass windows, which bikes currently lean against
- Replace the Comb racks on both sides of the main entrance with Coat Hanger racks with extended covering

Entrances to Dartmouth Hall

• Install 4 P&L racks on each side of both sets of front-entrance stairs

Steps of Fairchild

- Install a row of P&L racks along the cement retaining wall in front of Wilder
- Replace Comb racks at top of the stairs into Fairchild with a Coat Hanger rack
- Surround planter on steps with P&L racks

College St. Entrance to Steele

• Level the slope on right side of the steps and provide four 'A' racks

Front and sides of Baker

- Install a row of covered 'A' racks on either side of the main entrance
- Replace wave racks at side entrances with covered 'A' racks



Outside of Novack

- Install a row of P&L racks on the library side of the pillars on either side of the main entrance
- Replace Comb rack on Webster side entrance with several P&L racks around the pillar

Alumni gym

- Replace the racks to the left of the stairs with a covered parking area of Coat Hanger racks
- Include maintenance station

In front of Cutter Shabazz/ Sustainable Living Center

- Double the size of the cement parking pad, cover it, and replace wave with Coat Hanger racks
- Include maintenance station

Outside of Feldberg

• Provide covered 'A' racks at the top of the stairs that lead to Feldberg entrance

Ripley, Woodard, Smith

• Replace wave racks with covered 'A' racks

Front of McNutt

• Provide a ramp to wheel bikes up the stair to several covered 'A' racks, to replace the current Comb

Moore

• Double the available parking at main entrance, replace Waves with covered Coat Hanger racks



Outside River Apartments

- Move racks closer to entrances and make sure they are covered
- Replace Wave racks with Coat Hanger styles
- Include maintenance station

Sides of Gile, Lord, Streeter

• Provide covered Coat Hanger racks at all entrances

Outside Rockefeller Center Overhang

- Covered 'A' rack parking lot on the Tuck Mall side of the Rockefeller Center, which is currently unused lawn
- Include maintenance station

Top of the stairs on lower Tuck Drive

• Install a covered Coat Hanger rack at the top of the stairs that lead to the boathouse that rowers use to get to practice

Tuck entrance to Silsby

• Provide covered 'A' racks on either side of the entrance

Sudikoff

• Replace current Inverted U racks, located on the grass on the North side of the building, with 'A' racks placed on a cement parking pad

Another parking option that has become increasingly popular in US cities is to convert a single parking spot into a bike parking lot. These lots can often fit 10-15 bikes, and thus are often appealing options for locations with limited parking. However, we feel that this option is not well suited to Dartmouth's campus. Cyclists will always bike as close to their destination as possible, and we do not think that parking spaces are not close enough to most building entrances to be regularly used by campus cyclists. Additionally, street parking is in high demand and removing even a single spot would likely be met with strong pushback. Therefore we do not feel that this is a path worth pursuing.

Long-Term Storage

Overview

Students who own bicycles need a place to store their bikes when off-campus (i.e. during interim, for an academic term, or longer) and during terms in which they do not wish to bike (often the winter term). To that end, the College currently provides long-term controlled storage for bicycles in the Bissell, Channing Cox, Maxwell, New Hampshire, and Russell Sage dorms. The current policy for long-term storage is as follows¹²³:

- 1. Students must register their bike with Safety & Security
- 2. Students must bring their bicycle to one of the specified storage rooms
- 3. Students must pay a \$10 fee per bicycle per term
- 4. Students must pick up their bicycle within the term specified in the storage agreement
- 5. Bikes left in controlled storage for six months or more will be discarded
- 6. Students who store their bikes on a bike rack or any other area of campus (e.g. entry ramp, stairwell, etc.) may have their bikes impounded.

Evidence of current student practices demonstrates significant differences between policy and reality. Currently, according to survey data drawn from undergraduate and graduate students, students who own a bike use the following storage methods¹²⁴:

- 27% store their bike in a college-owned storage room
- 26% store in another indoor facility (e.g. Greek/Affinity house, off-campus, etc.)
- 20% store their bike on a bike rack meant for daily parking
- 27% lend, sell, discard, or store elsewhere

The most problematic storage method is bikes left on outdoor racks, for multiple reasons¹²⁵:

- Stored bikes limit space for daily parking.
- Stored bikes are left unprotected from weather, vandalism, and theft, leading to the ٠ destruction and abandonment of many bikes left on bike racks. The majority of abandoned bikes collected by the bike interns (approximately 100+ bikes per year) are found on outdoor racks.

¹²³ "Storage of Personal Property."¹²⁴ ENVS 50 Class.

¹²⁵ Dartmouth Bike Interns, personal interview.

Based on interviews and surveys of students, there appear to be several breaks within Dartmouth's current bike policy that a) do not adequately disincentivize students from storing their bikes outside and b) disincentivize students from storing their bikes in controlled storage. While reliance on controlled storage alone will likely not eliminate outdoor storage entirely, we recommend changes to current controlled storage practices in tandem with other policy changes in order to reduce the number of destroyed and abandoned bikes around Dartmouth's campus.

Causes of Outdoor Storage

It is necessary to understand the reasons students store their bikes on outdoor bike racks long-term in order to discourage the practice. Based on interviews with undergraduate students, the following are probable causes of outdoor storage¹²⁶:

- Lack of knowledge of bike rack policies: Many students do not know that their bikes may be impounded if left on racks for long periods of time (students' primary concerns with regard to rack storage are theft and weathering).
- 2. Lack of student effort in storing bikes: Students vary widely in the care they devote to their bikes, and many place little importance on caring for and properly storing their bicycles (especially during the hectic move-out period). While the bicycle storage rooms are relatively evenly distributed across campus, many students will not look for storage beyond their own dorms, and so will store their bikes on a conveniently located rack rather than walk it to a dorm storage facility.
- 3. Lack of enforcement of bike rack policies: Bike interns and Safety & Security impound bikes irregularly and unevenly across campus due to time and manpower constraints; as a result, racks are checked for stored bikes two to four times per year. The lack of regular enforcement allows students to store bikes on racks without consequences.
- 4. Lack of bike registration: Students can only store their bikes in controlled storage if they are registered, and many students do not know or care to register their bikes upon bringing them to campus (though registration is mandated). As such, they are then unable to store their bikes in controlled storage (and are very unlikely to go to the Safety & Security office to register their bikes while attempting to pack and move all of their belongings).

¹²⁶ Dartmouth Bike Interns, personal interview.

Proposed Improvements

Reducing bike waste and improving storage systems at Dartmouth will likely require a multifaceted approach. Below are the infrastructure-related improvements that this group most strongly recommends. The improvements are divided into two categories; the first are meant to disincentivize improper storage, and the second are meant to allow for and encourage better methods of storing bicycles on campus.

To disincentivize improper storage:

Both of the following recommendations regarding disincentivizing improper storage are policy changes, which will require approval by various offices within the College administration.

- 1. Further encourage and simplify bike registration: Accountability remains a primary challenge in improving biking at Dartmouth. We strongly recommend implementing a system wherein every student-owned bike on campus must be registered, so that students are held accountable for their bikes. The process of bike registration could be tied to safety, storage, and maintenance information (thus eliminating students' lack of knowledge regarding proper storage), as well as continue to allow students to store their bikes long-term on campus. To that end, the registration process should be simplified and made easily accessible to all students (see Education section for further information on this recommendation). Further incentives to encourage registration would also be welcome.
- 2. Fines and/or impoundment for bikes left on outdoor racks: In order to discourage storage on outdoor bike racks, we recommend that bike interns, S&S officers, or another party tag bikes on bike racks at the beginning of each term and fine the owners of those bikes left on racks for the entire term (the bike interns currently go through this process for bikes that appear damaged or abandoned, with the end result of impoundment rather than fines). The use of fines relies on the wide registration of bikes; hence the aforementioned need for increased registration. For those bikes that are not registered and are stored outside for the term, we suggest impoundment (this process should likely be phased-in over several years as the norm of bike registration, and the numbers of registered bikes, increases).

To incentivize proper storage:

Student effort (or lack thereof) remains a main obstacle to the proper storage of bicycles on campus. To that end, we recommend making bike storage as easy as possible and informing and encouraging students about proper storage systems. The recommendations in this section will only cover infrastructure-related changes; please see the Education and Encouragement sections for recommendations regarding disseminating information about these changes. We recommend the following mechanisms in order to make proper storage as easy and accessible as possible:

- Drop-off points for bike storage: As previously mentioned, bikes are not necessarily students' first priority, especially when packing and moving all of their belongings at the end of a term (the time when students most often need to store their bikes). As such, we recommend bike drop-off stations throughout campus during the reading, final exams and move-out period, at which students can drop off their bike for long-term storage. These stations should be located at high-traffic areas during the end of term; for example, we recommend (in order of importance):
 - a. In front of the Hop (where students meet busses)
 - b. Between Collis Student Center and the Class of 1953 Commons
 - c. Outside Baker-Berry library
 - d. In front of dorm clusters:
 - i. Behind Mass Row/Gold Coast
 - ii. Between Fahey-McLane and Russell Sage
 - iii. McLaughlin Cluster
 - iv. In front of Fayerweathers
 - v. River cluster (French, Judge, Channing Cox, Maxwell, etc.)

These stations would ideally be monitored, and the monitor (e.g. a bike intern or other paid student) would collect students' bikes, charge the fee to the students' ID cards, collect student's' signature on storage contracts, and ensure bike registration. Bikes would then be moved at end of day to one of the storage facilities. These stations would reduce the effort needed to store bikes, as they intersect with students' most common routes, and would also serve to remind students to store their bikes. (Students could also still personally leave their bikes at controlled storage if they so wished.)

- 2. On-site registration at drop-off points: In line with the above recommendations, students should be able to register their bike on-site at a drop-off site if not previously registered (so that registration is not a barrier to proper storage). Drop-off station monitors could take down students' information and supply them with a registration sticker, then relay the registration information to S&S.
- 3. Increased storage space: Currently, the Office of Residential Life (ORL) can house 150-160 bikes in controlled storage in dormitories at any given time¹²⁷. These bikes are both secured and insured, and can be stored in the following dorms: Bissell, Channing Cox, Maxwell, New Hampshire, and Russell Sage. ORL also has a few free, covered, and uninsured storage spots for bikes in most dorm clusters, which in combination with controlled storage leaves approximately 200-250 bike spaces in dorm storage¹²⁸. These spaces fill at the end of every spring term, forcing students to store bikes elsewhere (often outside)¹²⁹. Given the irregular distribution of controlled storage for bicycles around campus, the most useful place to expand storage would be in the Gold Coast and/or Mass Row dorms, given their central location and lack of controlled storage. This additional storage could take many forms, for example: a repurposed room within a dorm, an expansion of current storage, a small structure built next to dorms, a movable trailer, etc. The best solution will depend in part on which of the other recommendations in this report are realized (e.g. it may be more important to repurpose a room for bike maintenance than storage, or vice versa).

¹²⁷ S. Chambers, personal interview.

¹²⁸ S. Chambers, personal interview.

¹²⁹ S. Chambers, personal interview.

Bike Maintenance

Current State of Bike Maintenance Availability at Dartmouth

One of the most integral components to developing Dartmouth's bike culture is bike maintenance, and access to adequate maintenance facilities. Although Dartmouth already has a system for short-term and long-term bike storage, the College lacks a permanent system for bike maintenance. Presently, there is only one location at which students can repair their bike themselves, located in Robinson Hall, and there is no regularly operating station at which students can bring their bike to be repaired by another student or specialist. The College's only current solution to the issue of bike maintenance at Dartmouth is the Sustainability office's Pop-Up Bike Shop.¹³⁰

The Sustainability Office's Pop-Up Bike Shop

Typically run from the lawn in front of Robinson Hall, the Pop-Up Bike shop is the only place on campus for students to get their bike fixed at little-to-no cost. For 3 to 5 hours, the Sustainability Office's Bike Interns offer tune-up and bike inspection services for only the cost of any replacement parts. Bike Interns working at the Pop-Up Shop are paid \$10 an hour, and there are 2-3 Interns with bike mechanic skills at the Pop-Up Shop at any given time. ¹³¹The shop operates sporadically throughout the academic year, and is subject to weather delays, making it hard to bring your bike to the shop for regular or even one-time maintenance.

Analysis of Relevant Survey Data

The survey data obtained from undergraduate and graduate students puts into perspective the extent to which bike maintenance availability influences biking decisions at Dartmouth:

Of those students who frequently bike at Dartmouth, 28% cited bike maintenance as a ٠ reason why they might feel less than comfortable biking at Dartmouth, and 14% cited bike maintenance as a reason they chose not to ride a bike.

¹³⁰ Dartmouth Sustainability Office. Sustainability Office Internship Program. Hanover, NH: Dartmouth College, 2013. Sustainability.Dartmouth.edu, 2013. Web. 1 May 2014. ¹³¹ *Ibid*

- Of those students who rarely bike at Dartmouth, 31% cited bike maintenance as a reason why they might feel less than comfortable biking at Dartmouth, and 23% cited bike maintenance as a reason why they don't bike at Dartmouth.
- Of those students who don't have a bike at Dartmouth, 25% cited bike maintenance as a reason why they were less than comfortable biking at Dartmouth.
- The survey data also revealed the extent to which students felt comfortable fixing their own bikes, and which types of repairs they felt comfortable completing:
- 50% of students indicated they felt confident pumping up their bike's tires, and 15% of students said they felt confident changing their bike's inner tubes.
- 37% of students preferred that another student fix their bike at a station on campus, and 31% preferred that a professional fix it at a shop.¹³²

Suggested Improvements

Based on the above survey data and the current bike maintenance policy at Dartmouth, it is clear that improved access to adequate repair facilities and access to bike maintenance services are two major ways by which the College could increase ridership and ease of access to repairs across campus.

Permanent Bike Repair Stands

To improve the state of bike maintenance availability at Dartmouth, we suggest that the College install permanent public self-serve bike repair stands at strategic locations throughout campus. Such bike repair stands would be easy to use and readily accessible at certain heavily trafficked bike racks or paths. Northeastern University, Stanford University, and many other BFUs have recently installed numerous repair stands around their campuses, making it easier to perform quick bike repairs on the go.¹³³ DERO's Fixit model is currently the most popular public repair station at such BFU universities, equipped with all the tools



¹³² ENVS 50 Class. "Student Biking at Dartmouth." Survey. April 2014.

¹³³ St. Martin, Greg. "Bike Repairs Made easy." News Northeastern. Northeastern University, 18 Jan. 2013. Web. 29 April 2014.

necessary to perform basic repairs and an air pump for quick air refills. Both the tools and the air pump are securely attached to the station, with stainless steel cables a tamper-proof encasing. Riders can either scan the Quick Read (QR) code on the front of the stand, access accompanying online documentation, or use onsite instructions to learn how to perform basic maintenance tasks. DERO's stand costs approximately \$1000 with installation.¹³⁴ An alternative bike repair stand is the Saris Parking Cycle Aid Station, which is only equipped with maintenance tools



securely attached in a similar fashion. The Saris model costs \$695, and doesn't come with an air pump attachment. ¹³⁵ Both companies offer separate public air kit stations as well for about \$250 to \$195, respectively.¹³⁶ The College could implement a combination of both the DERO and Saris stands, depending each stand's proximity to the present existing Collis air station and other highly trafficked areas. We propose that the College install bike repair stands on the patio behind Collis and Robinson Hall, outside the Rockefeller Center Overhang, in front of the River Cluster, and on the Cutter-Shabazz and Sustainable Living Center front lawn.

Permanent Full-Service Bike Repair Shop

The above survey data also indicated a demand for increased accessibility to a fullservice bike repair station, serviced by either experienced students or professionals. Therefore, we suggest that the College establish a permanent full-service bike repair shop. Many BFUs such as Harvard and University of California, Davis have designated student-run bike repair shops. Quad Bikes, Harvard's non-profit bike shop, is open Tuesday through Saturday from 1pm- 6:30 pm. The cost to repair or replace bike parts at the shop depends on the cost of replacement parts and the amount of labor necessary to fix the bike, but the shop offers free estimates on repairs. Quad Bikes keeps most replacement parts and accessories on-hand for quick repairs, and sells a limited number of new and used bikes. Moreover, Quad Bikes has

¹³⁴ "Fixit." Dero : Overview. Dero, n.d. Web. 29 April 2014.

¹³⁵ "Cycle Aid Station." Saris Parking. Saris Parking, n.d. Web. 29 April 2014.

¹³⁶ ibid

remained one of the most heavily utilized and highly reviewed bike repair shops in Cambridge, MA for the past 10 years.¹³⁷

UC Davis' Bike Barn takes a slightly different approach, as it is completely student run and is only open to students, faculty, and staff of the university. The Bike Barn offers full-service repairs and is open Monday through Friday, from 9am to 4pm. Similar to Quad Bikes, the Bike Barn also offers free estimates and diagnosis. However, repairs costs are determined by 3 service plans: the \$75 Aggie Basic plan, the \$100 Aggie Complete plan, and the \$140 Aggie Elite plan. With the more expensive plans, students are provided with free accessory installation service, same-day flat service, and half-off the cost of a rental bike. The Bike Barn also sells new and refurbished bikes, and has most commonly used bike parts in stock. Defined by its high turnover rate of bike repairs, the Bike Barn has remained a successful enterprise for the past 20 years.¹³⁸

Based on these two precedents, we suggested that the College combine the above approaches and designate a space on campus as a permanent full-service bike repair shop and parts store, equipped with commonly used bike parts and accessories that are either purchased or repurposed from reclaimed bikes. The Sustainability Office's Bike Interns would perform bike repairs through the same number of hours of the current Pop-up Bike Shop, though on a more frequent basis throughout the academic term. Similarly to the current Pop-Up Bike Shop model, repairs would cost only the price of any parts used. Because the labor would be free, students and



 ¹³⁷ "Quad Bikes." *Quad Bikes*. Quad Bikes, n.d. Web. 4 May 2014
¹³⁸ "About | ASUCD Bike Barn." *ASUCD Bike Barn*. UC Davis, n.d. Web. 3 May 2014.

faculty would need to produce their Dartmouth IDs for access to the shop. Furthermore, the shop could rent out or sell refurbished bikes obtained from the mass of bikes abandoned throughout the campus.

Through these two initiatives, the College would assist students in maintaining their bikes and reducing abandonment due to maintenance issues, and hopefully increase overall bike use by making ownership more convenient for students.

Engineering Conclusion

These infrastructure suggestions provide options for improving bike transportation, shortterm parking, long-term storage, and bike maintenance at Dartmouth. While some suggestions are more feasible and cost-effective than others, we wanted to give a diverse array of suggestions for the College to consider when redeveloping the College's bike infrastructure. In order for Dartmouth to become a Bike Friendly University (BFU), campus infrastructure will have to improve to facilitate safer and easier bike transportation.

Conclusion

Cycling is one of the most sustainable and efficient modes of transportation that could bring tremendous social, economic, and environmental impacts to both individual and their communities. In this class, we have learned and researched about cycling at Dartmouth from three different components: encouragement, education and engineering, in the hope that this report could help facilitate a bicycle-friendly culture at Dartmouth. Through surveys and interviews, we have collected data from both students and off-campus commuters to learn about current issues related to cycling and how we can best address these issues. By researching about other schools and reviewing comments from BFU and the Hanover Town and Dartmouth Master Plans, we realized that there is a lacking of institutional structural assistance at Dartmouth in regard to fostering a sustainable bicycle friendly culture at Dartmouth. In order to make Dartmouth a BFU certified college, it is important for the college to take multi-faceted action toward infrastructure building, promoting educational programs and install encouragement among the College members. Therefore, in this report we have compiled a proposal for a bicycle-friendly university at Dartmouth. It was clear that many stakeholders in the Dartmouth community are playing a key role in the composition of the bike community at the College. We believe being a BFU is important. First, it facilitates a need to implement certain bike infrastructure that would support cycling on campus. Second, it facilitates a transformation in bike behavior that prompts a shift in bike culture. Students and other off-campus commuters would be more willing to cycle if they had the tools and access to bike infrastructure. Coupled with a bike culture that promotes cycling, it creates a synergetic effect where both students and off-campus commuters are willing to use a bike and have easy or adequate access to these tools. We would like to mobilize all the existing resources and apply some recommendations in this report to improve the conditions for cycling and ultimately shift Dartmouth to a more bicycle friendly campus. Since this proposal addresses the cycling problems from three important component of BFU, the tangible impact would be felt if all recommendations are initiated. However, we also acknowledge that some initiations represent greater investment from college and efforts aiming to implement a culture shift might require time to accomplish. For the greater benefits of Dartmouth as being a healthier, greener and more environmentally sustainable

campus, we would encourage the college to take long-term investments in order to achieve sustainable results that have benefits beyond the immediate goals. The college should promote more bike awareness programs or activities, as well as implementing the necessary bike infrastructure.

Appendix 1: Summary of Survey Responses

Which of these Dartmouth Bike initiatives have you heard of?

DartBikes	195	23%
Bike Pop-up Shops	216	26%
Emergency Ride Home	13	2%
Bike Storage	241	29%
Subsidized Bikes at Sustainable Move-In Sale	174	21%

How often do you ride a bike at Dartmouth?



Daily or Almost Daily	74	19%
A Few Times per Week	62	16%
Very Rarely or Never	70	18%
I don't have a bike	184	47%

Students Who Bike at Dartmouth Frequently

Rate your confidence level riding a bike at Dartmouth



If you are less than comfortable biking at Dartmouth, why?

Safety	36	32%
Not confident in my abilities/skills	17	15%
Bike Maintenance	32	28%
Bike Theft	28	25%

Where do you ride your bike on the Dartmouth campus most often?



Sidewalk	60	44%
Road	68	50%
Grass	0	0%
Bike lane	5	4%
Other	3	2%

Where would you prefer to bike?

Roads as they currently exist	35	16%
Sidewalks as they currently exist	26	12%
Specified bike lane on sidewalk	48	21%
Specified bike line on road	92	41%
Separate bike path, even if the route was less direct	24	11%

Did you use a bike before attending Dartmouth?



How many terms have you ridden your bike while at Dartmouth?



None	1	1%
1 term	15	11%
2 terms	20	15%
3 terms	23	17%
4 terms	13	10%
5+ terms	64	47%
What have you used your bike for?

Getting around campus (class, food)	133	28%
Getting around Hanover (Coop, main town, etc.)	109	23%
Getting around the Upper Valley for errands (Lebanon, West Leb, Norwich)	29	6%
Recreational biking around campus	58	12%
Recreational biking around the Upper Valley	44	9%
Mountain biking	13	3%
Bike racing	13	3%
Biking with the Cycling Club	8	2%
Biking to the Organic Farm	9	2%
Biking to sports facilities	59	12%
Other	3	1%

In which of the following reasons or situations do you choose NOT to ride a bike?

Weather and road conditions	128	54%
Locking up, maintaining, and storing a bike is too much of a hassle	33	14%
I'm not comfortable with my biking skills or knowledge of biking protocol	9	4%
I had a biking accident or know someone who had a biking accident	8	3%
I don't have the appropriate bike gear (helmet, lights, reflectors, etc)	7	3%
I have access to a car	29	12%
I live far from campus	3	1%
None of my friends bike	13	6%
Other	6	3%

If you use a car, what do you use it for?

Getting around campus (class, food)	22	10%
Getting around Hanover (Coop, main town, etc)	43	20%
Getting around the Upper Valley for errands (Lebanon, West Leb, Norwich)	82	39%
Casual drives around the Upper Valley	28	13%
Driving to the Organic Farm	6	3%
Driving to sports facilities	28	13%
Other	3	1%

Where do you store your bike when you're away from Dartmouth (e.g. interim or an off-term)?

Bike racks	36	19%
College-owned storage room	56	30%
Other indoor facility (Greek/Affinity House, Off-campus, etc.)	53	28%
Lend or rent for the term	14	7%
Sell, give away, forget about, or get rid of it	7	4%
Other	21	11%

If you were on a summer term and participated in the Prouty, what encouraged you to participate in or volunteer for the biking events?

Biking in the race	18	9%
Biking for fun	24	12%
Greek house competition	18	9%
Prizes and freebies	1	0%
My friends and I did it together	24	12%
Campus-wide excitement	18	9%
Opportunity to get involved in the Upper Valley	17	8%
Biking/volunteering for a good cause	24	12%
I was on for a summer term, but did not participate in or volunteer for the biking	32	16%
event		
I was not/have not yet been on for a summer term	28	14%

Students Who Bike at Dartmouth Rarely

Rate your confidence level riding a bike at Dartmouth

1	2	4%
2	2	4%
3	8	15%
4	27	49%
5	16	29%

If you are less than comfortable biking at Dartmouth, why?

Safety	16	24%
Not confident in my abilities/skills	13	19%
Bike Maintenance	21	31%
Bike Theft	18	26%

Why don't you bike at Dartmouth?

Safety	10	9%
I don't know how to ride a bike	1	1%
Not confident in my abilities/skills	8	7%
Bike maintenance	26	23%
It's more convenient to walk than bike around campus	40	36%
It's more convenient to drive than bike around campus	9	8%
Bike Theft	17	15%

In which of the following reasons or situations do you choose NOT to ride a bike?

Weather and road conditions	52	30%
Locking up, maintaining, and storing a bike is too much of a hassle	36	21%
I'm not comfortable with my biking skills or knowledge of biking protocol	11	6%

I had a biking accident or know someone who had a biking accident	5	3%
I don't have the appropriate bike gear (helmet, lights, reflectors, etc)	8	5%
I have access to a car	24	14%
I live far from campus	10	6%
None of my friends bike	19	11%
Other	10	6%

Did you use a bike before attending Dartmouth?



How many terms have you ridden your bike while at Dartmouth?



Where would you prefer to bike?

Roads as they currently exist	15	11%
Sidewalks as they currently exist	16	12%
Specified bike lane on sidewalk	37	27%
Specified bike lane on road	42	31%
Separate bike path, even if the route was less direct	25	19%

Where do you store your bike when you're away from Dartmouth (e.g. interim or an off-term)?

Bike racks	19	22%
College-owned storage room	18	21%
Other indoor facility (Greek/Affinity House, Off-campus, etc.)	17	20%
Lend or rent for the term	10	12%
Sell, give away, forget about, or get rid of it	9	11%
Other	12	14%

If you ever use a car, what do you use it for?

Getting around campus (class, food)	25	14%
Getting around Hanover (Coop, main town, etc.)	43	23%
Getting around the Upper Valley for errands (Lebanon, West Leb, Norwich)	55	30%
Casual drives around the Upper Valley	26	14%
Driving to the Organic Farm	5	3%
Driving to sports facilities	26	14%
Other	4	2%

If you were on for a summer term and participated in the Prouty, what encouraged you to participate in or volunteer for the biking events?

Biking in the race	4	4%
Biking for fun	7	8%
Greek house competition	12	13%
Prizes and freebies	1	1%
My friends and I did it together	12	13%

Campus-wide excitement	8	9%
Opportunity to get involved in the Upper Valley	7	8%
Biking/volunteering for a good cause	7	8%
I was on for a summer term, but did not participate in or volunteer for the biking	21	24%
event		
I was not/have not yet been on for a summer term	10	11%

Students Who Don't Have a Bike at Dartmouth

Rate your confidence level riding a bike at Dartmouth

1	11	7%
2	22	15%
3	34	23%
4	38	25%
5	46	30%

If you are less than comfortable biking at Dartmouth, why?

Safety	32	16%
Not confident in my abilities/skills	56	29%
Bike Maintenance	49	25%
Bike Theft	59	30%

Why don't you bike at Dartmouth?

Safety	22	8%
I don't know how to ride a bike	10	4%
Not confident in my abilities/skills	32	11%
Bike maintenance	41	14%
It's more convenient to walk than bike around campus	111	39%
It's more convenient to drive than bike around campus	20	7%
Bike Theft	47	17%

What have you used a bike for?

Getting around campus (class, food)	68	35%
Getting around Hanover (Coop, main town, etc)	42	22%
Getting around the Upper Valley for errands (Lebanon, West Leb, Norwich)	6	3%

Recreational biking around campus	26	13%
Recreational biking around the Upper Valley	10	5%
Mountain biking	2	1%
Bike racing	1	1%
Biking with the Cycling Club	1	1%
Biking to the Organic Farm	3	2%
Biking to sports facilities	21	11%
Other	13	7%

How many terms have you ridden a bike while at Dartmouth?



None	111	61%
1 term	31	17%
2 terms	19	10%
3 terms	12	7%
4 terms	6	3%
5+ terms	2	1%

Did you use a bike before attending Dartmouth?



If you ever use a car, what do you use it for?

Getting around campus (class, food)	46	12%
Getting around Hanover (Coop, main town, etc)	91	23%
Getting around the Upper Valley for errands (Lebanon, West Leb, Norwich)	134	34%
Casual drives around the Upper Valley	45	11%
Driving to the Organic Farm	19	5%
Driving to sports facilities	54	14%
Other	11	3%

If you were on for a summer term and participated in the Prouty, what encouraged you to participate in or volunteer for the biking events?

Biking in the race	6	3%
Biking for fun	15	6%
Greek house competition	34	14%
Prizes and freebies	3	1%
My friends and I did it together	28	12%
Campus-wide excitement	20	8%
Opportunity to get involved in the Upper Valley	13	5%
Biking/volunteering for a good cause	24	10%
I was on for a summer term, but did not participate in or volunteer for the biking	60	25%
event		
I was not/have not yet been on for a summer term	37	15%

Bike Maintenance at Dartmouth

Which of the following repairs are you confident completing?

I can pump up my tires	167	50%
I can change my inner tubes	51	15%
I can clean, lubricate, and change my bike chain	55	17%
I can fix my brakes	31	9%
I can fix my derailleurs	16	5%
I can fix anything on my bike	12	4%

If your bike breaks, how would you prefer to fix it?

I fix it with my own or a friend's tools	64	20%
I fix it with public tools at a self-maintenance station on campus	39	12%
Another student fixes it at a station on campus	121	37%
Professionals fix it at a shop	101	31%

Please list something you would like to learn about bike riding, maintenance or safety.

- How to grease the chain
- How to fix bike brakes.
- Is it safe to leave my bike outside in the winter?
- I'd like to know how to tune up the brakes.
- Fix derailleurs and breaks would be awesome
- I'd like to know more about campus options for bike storage, especially for leave-terms.
- How to change a road bike tire where to store my bike when it rains/snows
- Everything about maintenance.
- I don't know how to fix a bike at all.
- How to fix my chain falling off!
- Nothing

- The above suggests there are public self-maintenance stations. Where are these?
- All the basic fix-ups and maintenance
- How to properly plow over pedestrians.
- Deal with chains.
- Lubricating chain and breaks
- How to dismount better
- Everything -- 1-day comprehensive course would be awesome
- Biking street rules
- How to fix my chain if it comes off whether it is better to bike on road or sidewalk
- All unchecked repairs listed above free maintenance??
- I'm interested in learning more about the helmets developed in Europe that you wear around your neck. http://www.hovding.com/how_it_works/ I would totally wear one of these! But, they are expensive. Therefore, I don't wear a helmet. I do ride a beach cruiser though.
- How to road bike adjusting brakes and cables
- Details of maintenance
- Learn how to fix anything on my bike
- How to ride one
- How to maintain my bike
- Learn how to fix my bike
- Biking etiquette in a small town like Hanover how to change chains
- Why people over the age of 12 ride their bicycles on sidewalks when this is in violation of town ordinances
- Where is the nearest bike shop so I can buy new brake pads?
- The chain---everything about maintaining it
- How to protect the bike chain from rust
- How to change my popped tube
- All basic maintenance
- Caring for bike chain
- Fixing pneumatic brakes and derailleurs

- How to repair squeaky brakes
- How to fix a tire
- How to fix my brakes
- How to fill tires
- Fix brakes
- Signaling
- Changing inner tubes wheel building
- How to fix brakes and derailleurs
- Hanover and NH have great road biking. I would like to learn how to become a competent road biker, whether that be through a club open to beginners or a class.
- How to fix brakes
- How to keep the chain from getting rusty
- Something like http://bicyclesafe.com/ but more specified to our region tubeless tires how to bike safely in downtown Hanover.
- How to fix my brakes.
- Is it legal to bike on the sidewalk?
- Tuning gears
- Where to find maintenance at low cost
- What are ways to make owning a bike less of a hassle?
- How to adjust derailleurs I would love to learn more basic maintenance, especially of gears/chain and brakes
- Long-term plan for bicycle infrastructure for Dartmouth commuters within ~10 mile radius
- How to make sure my chain is working properly
- I need to learn how to change my tires if I get a flat
- What am I supposed to do for maintenance besides pump up tires??
- How to fix derailleurs/gears

If Dartmouth offered a PE course about bicycling skills, maintenance, and safety, would you take it?



Yes	101	26%
No	284	74%

Would you like to see more Dartmouth-specific information online about bicycle safety, maintenance, storage, etc. (e.g. on one unified page within Dartmouth.edu)?



Yes	268	69%
No	119	31%

Bibliography

"About | ASUCD Bike Barn." ASUCD Bike Barn. UC Davis, n.d., 3 May 2014. Web.

- "About Yale University." 2014. Web. http://www.yale.edu/about/history.html/
- "Additional Employee Benefits." Office of Human Resources at Dartmouth College Website. 2014. Web. April 2014.
- "Benefits of Bicycling." Dartmouth Green Commute Website. 2013. Web. April 2014. http://sites.dartmouth.edu/greencommute/bike/
- "Bicycles." National Highway Traffic Safety Administration, 1 Jan. 2011. Web. 12 May 2014. http://www.nhtsa.gov/Bicycles/
- Bicycle Benefits Website. 2014. Web. April 2014. < http://bb2.bicyclebenefits.org/>
- Bicycle Friendly Community Feedback Report, Hanover, NH. Spring 2013.
- "Bicycle Parking." University of Minnesota. Parking and Transportation Services. Web. https://www1.umn.edu/pts/bike/bikeparking.html/
- "Bicycle Registration." Department of Safety and Security, 4 June 2008. Web. 30 Apr. 2014. <www.dartmouth.edu/~security/services/bikereg.html/>
- Bike Commuter Personal Interview Data. April-May 2014.
- "Bike Parking Racks Fact Sheet." Bicycle Coalition of Greater Philidelphia. Web. <Bicycle Coalition of Greater Philidelphia>.
- "Bike Route Wayfinding Signage and Markings System." *NACTO*. National Association of City Transportation Officials. 21 May 2014. Web. http://nacto.org/cities-for-cycling/design-guide/bikeway-signing-marking-old/bike-route-way-finding-signage-and-markings-system/
- "Bike Share Business Plan 2012" Kier, Laura, and Benjamn Hughey. Dartmouth College: Office of Sustainability, June 2012.
- "Bike Sharing Program at UVM." University of Vermont. Web. 21 May 2014. http://www.uvm.edu/sustain/node/1190/
- "Blue Bikes Program." University of Maine. Web. 21 May 2014. http://umaine.edu/mainebound/bluebikes/

- "Bowdoin Yellow Bike Club." 2013. Bowdoin College. Web. http://students.bowdoin.edu/yellow-bike-club/
- Bradley-Cook, J. Personal interview. April 8, 2014.
- "Campus Planning and Facilities." 2014.Web. http://www.dartmouth.edu/~cpf/
- Collier, J. Personal interview. April 22, 2014.
- "Current Bicycle Friendly Universities Spring 2013." The League of American Bicyclists, 2013.Web. http://bikeleague.org/sites/default/files/bfu master award list spring 2013 web.pdf/>

"Cycle Aid Station." Saris Parking. Saris Parking, n.d. Web. 29 April 2014.

- Dartmouth Bike Interns. Personal interview. 27 Apr. 2014.
- "Dartmouth College." U.S. News & World Report. Web. 3 May 2014. http://colleges.usnews.rankingsandreviews.com/best-colleges/dartmouth-college-2573/
- Dartmouth College Master Plan: Green Traffic Circulation Assessment, 2013. RSG Transportation Inc., April 2013.

Dartmouth College Parking and Commuter Survey, 2009. RSG Transportation Inc., 2009.

Dartmouth College TDM Strategies, March 2013. BFJ Planning, 2013.

- Dartmouth Parking and Transportation Service, Dartmouth. Web. 21 May 2014. http://www.dartmouth.edu/~fom/services/parking/
- Dartmouth Sustainability Office. *Sustainability Office Internship Program*. Hanover, NH: Dartmouth College, 2013. Web. 1 May 2014. <sustainability.dartmouth.edu/>
- "Dero Zap Bike Commuter Counter". Web. April 2014. http://www.dero.com/products/zap/zap-description.html/
- Drysdale, S. Personal interview. April 16. 2014.

Eisenberg, Sheryl. "Bike Sharing: Coming Soon to a City Near You." This Green Life (2013).

ENVS 50 Class. "Student Biking at Dartmouth." Survey. April 2014.

ENVS 50 Class. "Bike Share". Survey. April 2014.

"Fitness Reimbursement Benefit." *Wellness at Dartmouth Website*. 2014. Web. April 2014. ">http://www.dartmouth.edu/wellness/fitness/wellness_benefit.html/> "Fixit." Dero : Overview. Dero, n.d. Web. 29 April 2014.

- "Green Lanes, Archives" *BicycleMobile.org News Issues Advocacy Bicycling in Mobile* AL RSS. Web. 21 May 2014. http://www.bicyclemobile.org/category/green-lanes/
- "Green Revolving Funds: An Introductory Guide to Implementation & Management" Indvik, Joe, Rob Foley, and Mark Orlowski. *Sustainable Endowments Institute & the Association for the Advancement of Sustainability in Higher Education*, Jan. 2013. Web. 21 May 2014. http://greenbillion.org/>
- Hendriksen, I.J.M. (2010). "The association between commuter cycling and sickness absence". *Preventive medicine (0091-7435)*, 51 (2), p. 132.

Howarth, Richard. Personal interview. April 14, 2014.

Kerr, Rosi. Personal interview. April 29, 2014.

"Landscaping at Bowdoin." 2014. Bowdoin College. Web. https://www.bowdoin.edu/sustainability/buildings-grounds/landscaping.shtml/

Leger, J. Personal interview. 16 May 2014.

Lutz, D. Personal interview. May 3, 2014.

- Mellert, H. Personal interview. May 2, 2014.
- "Middlebury Bike Shop Program." Middlebury College. Web. 21 May 2014. http://www.middlebury.edu/middlebury_google_custom_search/go/bike/
- Miner, M. Personal interview. April 18, 2014.
- "MOVE It Challenge." Wellness at Dartmouth Website. 2014. Web. April 2014. http://www.dartmouth.edu/wellness/general/moveit.html/
- Morgan, Helen. "Armadillo: Cool Recycled Plastic Bike Lane Dividers Keep Cyclists Safe on Roads." Inhabitat: Design Will Save the World. Web. 4 May 2014. http://inhabitat.com/armadillo-cool-recycled-plastic-bike-lane-dividers-keep-cyclists-safe-on-roads/

Newcomb, A. Personal interview. April 30, 2014.

Olmsted, Richard. Dartmouth College, Offices of Administration, July 1971.

"Our Classes." League of American Bicylicsts, 15 Nov. 2013. Web. 30 Apr. 2014. http://bikeleague.org/content/take-class/>

- "Outdoor Bike Racks." *ParkItBikeRacks.com*. N.p., n.d. Web. http://www.parkitbikeracks.com/outdoor-bike-racks.html/
- Pedestrian and Bicycle Master Plan: Town of Hanover, New Hampshire. ORW Landscape Architects and Planners. October 2011.
- Plunkett, D. Personal interview. May 2, 2014.
- "Quad Bikes." Quad Bikes. Quad Bikes, n.d. Web. 4 May 2014.
- Sanders, S. Personal interview. April 14, 2014.
- Schmidt, Jack, et al. Bike Share Opportunities in New York City. New York, New York: NYC Department of City Planning, Transportation Division, 2009. Print.
- Schweitzer, I. Personal interview. April 24, 2014.
- Social Bicycles Customer Overview. Social Bicycles, 2014. Print.
- Space Management at Dartmoth, 2013. Web. 21 May 2014. http://www.dartmouth.edu/~opdc/pdfs/20120617_ivyplus_cornell.pdf/
- St. Martin, Greg. "Bike Repairs Made easy." *News Northeastern*. Northeastern University, 18 Jan. 2013. Web. 29 April 2014.
- "Stanford Campus Site Furnishing Guidelines." Stanford University Architect and Planning Office, Nov. 2006. Web. http://maps.stanford.edu/sites/all/lbre-shared/files/docs_public/UA-CPD_BikeParking_V3_2010Aug25.pdf
- "Storage of Personal Property." *The Office of Residential Life*. Trustees of Dartmouth College, n.d. Web. 2 May 2014. http://www.dartmouth.edu/~orl/res-ops/storage.html/
- Sullivan, C. Personal interview. April 13, 2014.
- "Take a Bike." Bentley University. Web. 21 May 2014. http://www.bentley.edu/offices/sustainability/take-bike/
- "Take a Bike Class." *League of American Bicyclists Website*. 2014. Web. April 2014. http://bikeleague.org/content/take-class/>
- "The 5 E's." *League of American Bicyclists*. N.p. Web. 21 May 2014. http://bikeleague.org/content/5-es/
- "To Slow down Speeding Traffic, Tompkins County Experiments with Painting Roadside Green." *The Post-Standard*. Sept. 16 2012. Web.

<http://www.syracuse.com/news/index.ssf/2012/09/to_slow_down_speeding_traffic.html >

- "Traffic Calming Measures Speed Table." *Institute of Transportation Engineers -- ITE*. Web. 21 May 2014. http://www.ite.org/traffic/table.asp/>
- "Trail Finder." Upper Valley Trails Alliance, 1 Jan. 2014. Web. 26 Apr. <2014.trailfiner.info/uppervalley>
- "Transportation and Parking Service." Princeton University. Web. 21 May 2014. http://www.princeton.edu/transportation/regulations.html/
- "Transportation and Parking Services: UVM." 2014. University of Vermont. Web. http://www.uvm.edu/~tpswww/
- "UNE's alternative transportation bike program." University of New England. Web. 21 May 2014. http://www.une.edu/news/2010/unebicycleprogram.cfm>
- Welker, M. Personal interview. April 18, 2014.
- Whitcomb, J. Personal Interview. 18 April 2014.
- Wilson, J. Personal interview. April 14, 2014.
- Woodruff, Mandi. "13 reasons you should bike to work." Business Insider. October 2012. Business Insider Web. April 2014. <<u>http://www.businessinsider.com/13-reasons-you-should-bike-to-work-2012-10></u>
- "Yale Bikeshare." 2014. Web. < http://to.yale.edu/yale-bikeshare>
- "Yellow Bike Program." Bowdoin College. Web. 21 May 2014. http://students.bowdoin.edu/yellow-bike-club/