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Bicycle and Pedestrian Engineering Design Curriculum Expansion

Ashley Haire
Portland State University

OTREC

OREGON TRANSPORTATION RESEARCH AND EDUCATION CONSORTIUM

FINAL REPORT

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OTREC-ED-11-03
February 2012

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BICYCLE AND PEDESTRIAN ENGINEERING DESIGN CURRICULUM EXPANSION

Final Report

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by

Ashley R. Haire, Ph.D.
Portland State University

for

Oregon Transportation Research
and Education Consortium (OTREC)
P.O. Box 751
Portland, OR 97207

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16. Abstract

Bicycle and pedestrian issues are gaining nationwide attention in transportation curricula. More programs seek to offer courses specifically geared towards bicycle and pedestrian planning and design goals, although fewer than 20 known courses are currently offered at universities across the US. Most of these known courses are offered in planning departments and do not delve into engineering details of design. This report describes the development and delivery of a new bicycle and pedestrian engineering design course offered at Portland State University in Winter Term, 2011, which was well-received and included undergraduate and graduate students in civil engineering and planning.

The course was structured similarly to a traffic engineering course and, among other pedestrian- and bicycle-specific issues, covered topics that might be addressed in a traffic engineering or geometric design course, but from the perspective of the cyclist or pedestrian. Augmenting course notes delivered in class and homework assignments focusing predominantly on practical fieldwork and associated solutions, the course included a term project in which students worked in teams to evaluate the functionality and design of several pedestrian and/or bicycle hybrid signals in Portland.

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DISCLAIMER

EXECUTIVE SUMMARY

Bicycle and pedestrian issues are gaining nationwide attention in transportation curricula. More programs seek to offer courses specifically geared towards bicycle and pedestrian planning and design goals, although fewer than 20 known courses are currently offered at universities across the U.S. Most of these known courses are offered in planning departments and do not delve into the engineering details of design. This report describes the development and delivery of a new bicycle and pedestrian engineering design course offered at Portland State University (PSU) during the winter term of 2011, which was well-received and included undergraduate and graduate students in civil engineering and planning.

The course was structured similarly to a traffic engineering course and, among other pedestrian- and bicycle-specific issues, covered topics that might be addressed in a traffic engineering or geometric design course, but from the perspective of the cyclist or pedestrian. Augmenting course notes delivered in class and homework assignments focusing predominantly on practical fieldwork and associated solutions, the course included a term project in which students worked in teams to evaluate the functionality and design of several pedestrian and/or bicycle hybrid signals in Portland.

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1.0 BACKGROUND AND OBJECTIVES

The thoughtful and educated development and provision of active transportation facilities enhances the livability and health of communities. As federal, state and local governments seek to encourage active transportation, bicycle and pedestrian facility design is receiving greater consideration in the development of "complete streets" and multimodal transportation systems. Preparing the next generation of transportation engineers and planners with the skills they need to raise awareness of non-motorized mode accommodations and implement well-informed bicycle and pedestrian facility designs requires providing necessary training.

Bicycle and pedestrian issues are gaining nationwide attention in transportation curricula. More programs seek to offer courses specifically geared towards bicycle and pedestrian planning and design goals, although fewer than 20 known courses are currently offered at universities across the U.S. Portland State University (PSU) currently offers one of these courses, which touches on planning considerations for bicycle and pedestrian facilities.

This project introduced a new course to PSU's bicycle and pedestrian curriculum, focusing course material on engineering design issues surrounding bicycle and pedestrian facility design and location. The course is one of only three documented bicycle and pedestrian facility design courses offered through U.S. university engineering departments. Most of the existing courses focused on planning concepts. Topics covered in the class included human factors in design, facility location and layout, geometric design of roadways and intersections for bicycle and pedestrian use, illumination and signalization considerations, intermodal connectivity, and safety and health components of facility design, among other subject matter. The engineering- and design-focused content in the course developed in this project acts in a complementary manner for those students enrolling in both this course and the existing course in PSU's planning department.

The project builds on current engineering education research by the principal investigator (PI), focused on addressing educational needs of students through the use of innovative classroom techniques, multidisciplinary generative problem solving, cooperative learning and classroom engagement. In addition, an Advisory Committee comprised of Portland experts in bicycle and pedestrian facility design and operations assisted in all stages of the course, providing advice, feedback, professional perspective and course material review. This involvement from the local professional community enriched the course by providing opportunities for tangible, applied project work throughout the course term.

2.0 PROJECT DESCRIPTION

The primary goal of this project was to develop and deliver a successful upper-division undergraduate and graduate engineering course focused on the design of bicycle and pedestrian facilities. The process of creating this course concurrently produced guidance for development of similar courses at other universities.

Material for lectures, assignments and projects was generated from a variety of sources. These included:

(1) Adaptation of content from the instructor/PI's graduate engineering coursework at other universities, including traffic engineering and geometric design.

(2) The 1999 AASHTO Bike Book[1] and draft version of the new AASHTO Guidance for the Design of Bicycling Facilities[2].

(3) AASHTO Pedestrian Book[3].

(4) The Dutch CROW Manual[4].

(5) Consultation with the project Advisory Committee, which included Peter Koonce, Roger Geller, Denver Igarta and Sarah Figliozzi of the City of Portland Bureau of Transportation (PBOT).

(6) Materials obtained from the Pedestrian and Bicycle Information Center (PBIC) at the University of North Carolina (http://www.pedbikeinfo.org/).

This project supported one graduate research assistant at a 0.40 appointment. The research assistant's role included location of supporting course material and creation of a website for the course, used both for access to course materials by enrolled students and for enhanced visibility of the course to interested parties.

The course was delivered during PSU's Winter 2011 term. Originally, the course enrollment was capped at 20 students, but due to the unexpected and overwhelming popularity of the course among civil engineering undergraduate and graduate students and urban studies/planning graduate students, the enrollment was expanded to include 27 students.

3.0 OUTCOME AND RESULTS

The course was generally designed along a similar framework as a traffic engineering course might be. In this way, topics progressed from concepts of user types and human factors in design, to appropriate locations for a variety of facility types, to the details on how those designs might be accomplished. Throughout the term, readings were assigned and followed by class discussions on the important points from the readings. Readings were selected less for their vitality to bicycle and pedestrian research and more with the goal of introducing students to interesting approaches to bicycle and pedestrian research and to touch on innovative concepts in the field. The complete syllabus, including lecture topics and assigned readings, can be found in the appendix to this report.

The topics covered in the bicycle and pedestrian engineering design course developed in this project included:

- Bicycling and pedestrian facility user types and human factors in design;
- Perception-reaction time and stopping sight distance;
- Bikeability, walkability and level of service;
- Design considerations for sidewalks;
- Roadway classification hierarchy and appropriateness for bicycle facilities;
- Stopped-time delay for cyclists at signalized intersections;
- Safety considerations and driver awareness;
- Road diets and redesigning existing roadways to include safe cycling facilities;
- Traffic calming: types, purposes and appropriateness;
- Intersection design;
- Bicycle detection technologies;
- Basic signal-timing concepts and relevance to bicyclists; and
- Supportive infrastructure and bicycle parking.

Lecture notes were delivered in a methodical progression using the traditional approach of writing on the board. Where possible, guided student discussion was encouraged in creating the notes - students responded favorably to what they deemed “making their own notes.” For example, in discussing the types of users in pedestrian and cycling facilities, and the differing design vehicles one may have to account for in design, discussion-based brainstorming kept students engaged and participatory while generating more comprehensive course notes. Many

students in the class were regular cyclists and enjoyed relaying their personal experiences and sharing their viewpoints on class topics.

In addition to the materials covered in class through lectures and assignments, an applied course project was developed in coordination with members of the Advisory Committee at PBOT. The students worked in four-person teams to evaluate seven pedestrian or bicycle hybrid signals around Portland. Sites were chosen based on the priority of investigative needs by PBOT - some sites had known operational complexities and others were the source of public requests for improvement. Drawing on knowledge from this class and previous coursework, students collected data at the sites, reviewed video data collected by PBOT, and made observations of user behavior (including motorists) to assess the functionality of the installation and recommend safety and operational improvements. As part of this term project, students were required to prepare and deliver a professional presentation and final report, materials from which were transmitted to PBOT for use in addressing concerns at the sites.

In addition to providing students with opportunities to pursue tangible projects and assignments making use of field data and observations, the course aided PBOT in pursuing improvements at the selected project sites and solicited design suggestions for retrofitting existing roadways designated as future bicycle corridors. The results of these efforts were later picked up by local media, including OTREC “tweets” on Twitter.com, and by local bicycle advocacy groups such as the local BikePortland blog (bikeportland.org). The instructor also registered the course with the PBIC’s registry of university-level bicycle and pedestrian courses, and has subsequently been contacted by multiple parties from around the U.S. who are interested in developing similar courses.

4.0 FURTHER ACTIVITIES

It is hoped that this report will aid future instructors in developing and delivering engineering-based courses focused on bicycle and pedestrian facility design. The following challenges are anticipated in continued delivery of the course:

(1) Determination of, and preparation of materials related to, an appropriate course project.

Selection of the course project required extensive coordination with the Advisory Committee and PBOT, particularly regarding collection of the video data at the sites. Although development of course notes and administration of lectures can be relatively straightforward once these notes have been assembled, identification of a relevant and timely project and generation of the associated materials may still require substantial additional effort on the instructor's part.

(2) In locations where students have little experience as cyclists or interacting with them in the roadway environment, extra activities may be needed to reinforce particular concepts.

Portland is a rich environment for cyclists and pedestrians, where these road users are given more respect and attention than in other locations. Students in this course were already familiar with well-designed bicycle and pedestrian infrastructure and therefore many concepts could be covered in less detail - for example, making the distinction between bicycle lanes and bicycle boulevards. In other regions, more time may be needed to discuss differences in these facilities, perhaps with relevant visual aids or pictures. Vulnerability, safety and security concepts may require additional reinforcement in classes not composed of regular cyclists.

5.0 REFERENCES

1. American Association of State Highway and Transportation Officials (AASHTO). *Guide for the Development of Bicycle Facilities*. 1999. http://safety.fhwa.dot.gov/ped_bike/docs/b_aashtobik.pdf.

2. American Association of State Highway and Transportation Officials (AASHTO). *AASHTO Guide for the Planning, Design, and Operation of Bicycle Facilities (Draft)*. February 2010. http://design.transportation.org/Documents/DraftBikeGuideFeb2010.pdf.

3. American Association of State Highway and Transportation Officials (AASHTO). *AASHTO Guide for the Planning, Design, and Operation of Bicycle Facilities*. July 2004.

4. CROW. *Design Manual for Bicycle Traffic*. 2007.

APPENDIX – COURSE SYLLABUS

Department of Civil & Environmental Engineering
Room 200, Engineering
www.cee.pdx.edu
503-725-4282

Course Number	410 (Undergraduate) 510 (Graduate)
Title	Bicycle and Pedestrian Engineering Design
Section	012
CRN(s)	44229 (Undergraduate) 44235 (Graduate)
Credits	2
Prerequisite(s)	CE351 or consent of instructor
Days/Time	Thursdays, 12:00 PM to 1:50 PM
Location	EB 315 (ITS Lab)
Final Exam Day/Time	Thursday, March 17, 10:15 AM to 12:05 PM, EB 315
Course Website	http://web.cecs.pdx.edu/~haire/bikepeddesign.html
Instructor	Dr. Ashley R. Haire
Office	301R Engineering Building
Phone	503-725-8928
E-mail	haire@pdx.edu
Office Hours	Monday 2-3 PM, other times by appointment
Mailbox Location	OTREC Office, Engineering Building Room 300

Required Text or Other Materials:
Readings as assigned (see page 6 of this syllabus).

Catalog Course Description
Design and operational concepts in the engineering design of bicycle and pedestrian facilities in on-road and shared path locations. Specific topics include basic geometric design, intersection and signalization considerations, and amenities supporting non-motorized modes.

Course Statement
Bicycling and walking are vital modes in urban transportation systems and address a public health need for physical activity. Design of non-motorized facilities in predominantly auto-oriented US cities requires consideration of numerous factors relating to safety, accessibility, connectivity, and ease of use. Appropriately selected amenities and technologies can further support the inclusion of bicycle and pedestrian facilities in the greater transportation network.

Course Objectives – Students must demonstrate the ability to:

1. Explain key concepts in non-motorized transportation facility design and operations.
2. Understand issues facing non-motorized transportation system design.
3. Describe and be able to identify key design features in non-motorized on-road and shared path facilities.
4. Evaluate the design effectiveness of non-motorized transportation facilities.
5. Discuss how non-motorized modes can be addressed in transportation system design.

Course Evaluation
The course grade will be determined with the following weight for class assignments:

Undergraduate and Graduate Students:

Class Participation:	15%
Homework:	20% (4 @ 5% each)
Class Project:	25%
Final Exam:	40%

This course is open to both graduate and undergraduate students, and as such, there will be different expectations for each group. *Graduate students are held to higher standards when grading and may be required to do more work on homework assignments and exams*. If I have made a mistake in

recording your grade, please send me an email with subject heading "grade correction" notifying me of my error. I will ask you to show me the corrected assignment. For this reason, save all your returned work!

A grade of incomplete "I" is granted by the instructor *only* with prior approval and consent. Criteria are outlined in the PSU Bulletin.

Expectations of the Student

Professionalism
All assignments and class participation should be conducted in a professional manner. Attention to detail on class assignments and communication is important and is part of the learning experience and is included in part of student evaluation.

Attendance
Attendance is strongly suggested. We will do activities in class that will help in your learning of the material that cannot be duplicated outside of the classroom. If you are going to miss a class, I suggest that you email me before with a reason stating why you will miss class. 10% of your grade is based on class participation, which requires your presence in the classroom. Course notes will be given on the whiteboard and will not be available electronically. For this reason, you are encouraged to attend all class sessions. If you miss a class, plan to obtain the missed course notes from a classmate.

Late Work
Late work is not accepted. The due date for each assignment is clearly indicated and the work must be turned in at the start of class unless indicated otherwise. Exceptions can only be granted in the most extenuating circumstances.

Computer and E-mail Accounts
Electronic mail is a useful way for us to remain in contact and is the best way to reach me. I ask that you include CE410/510 and topic of your message in the subject line (be as specific as possible) when sending me an email. Use proper grammar, spell check, and proof your message. Before you ask a question, please do due diligence and try to find the answer yourself. You may be required to submit some of your assignments electronically.

Ethics and Professionalism
As future professional engineers you should plan to take the Fundamentals of Engineering Exam and after the required experience, the Professional Engineering Exam (see the Oregon State Board of Examiners for Engineering and Land Surveying at www.osbeels.org). You should also be familiar with the ASCE Code of Ethics (www.asce.org/inside/codeofethics.cfm), which includes the following:

Engineers shall act in such a manner as to uphold and enhance the honor, integrity, and dignity of the engineering profession.

The PSU Student Conduct Code prohibits all forms of academic cheating, fraud, and dishonesty. Further details can be found in the PSU Bulletin. Allegations of academic dishonesty may be addressed by the instructor, and/or may be referred to the Office of Student Affairs for action. Acts of academic dishonesty, including plagiarism, may result a failing grade on the exam or assignment for which the dishonesty occurred, disciplinary probation, suspension or dismissal from the University. The students and the instructor will work together to establish optimal conditions for honorable academic work. Questions about academic honesty may be directed to the Office of Student Affairs (www.ess.pdx.edu/osa/).

Course Schedule (Tentative)

#	D	Date		Topic	Problem Set	Due Dates
1	Th	6-Jan	Basic Facility Design and Serviceability	Introduction to course; Types of users; PIEV time; stopping sight distance		
2	Th	13-Jan		Bikeability, walkability, route design; level of service	Homework #1	27-Jan
3	Th	20-Jan		Cross-sectional design: types of facilities		
4	Th	27-Jan		No class – Meet to work on group projects (Transportation Research Board Conference)	Homework #2	10-Feb
5	Th	3-Feb		Safety; traffic calming; road diets		
6	Th	10-Feb		Intersections; bike detection Guest lecture: John Shearer, Iteris, Inc.	Homework #3	17-Feb
7	Th	17-Feb		Signalization and lighting Guest lecture: Peter Koonce, PBOT		
8	Th	24-Feb		Supportive infrastructure and bike parking Guest lecture: Sarah Figliozzi, PBOT	Homework #4	10-Mar
9	Th	3-Mar	In-class project presentations			
10	Th	10-Mar	Guest lecture: Roger Geller, PBOT; Course review			
11	Th	17-Mar	**Scheduled Final Exam: Thursday, March 17 10:15 AM – 12:05 PM**			

Description of Assignments

Assignments due on class days are due at the beginning of class (hard copy). ***Only in extenuating circumstances will electronic submittals be allowed.***

Class Participation (15% of final grade)
This class will be very interactive. For this reason, it is important that you come to class prepared to be involved and engaged. 15% of your final grade will be based on your classroom engagement.

Homework (20% of final grade)
There will be 4 homework assignments, each worth 5% of your grade. Homework will be assigned during the class session and available on the course website, and will be due as indicated on the timeline (page 3 of this syllabus). Your name, homework assignment number, and date should appear on the header of each page. Please staple multi-page assignments.

Class Project (25% of final grade)
There will be a class project in which you will work in 5-person teams. The grade you receive will be based on the quality of your team's final report and in-class presentation of your findings.

Final Exam (40% of final grade)
In this class, there will be one final exam. The final exam will take place per the university finals schedule as indicated on page 3 of this syllabus and will be comprehensive, on material covered throughout the duration of the class.

Resources

Student Groups and Professional Organizations
Participation in student and professional groups can be a valuable part of your education experience. Membership gives students opportunities to get to know fellow students better, meet and network with professionals, collaborate in solving real engineering problems, learn about internship or job possibilities, socialize and have fun. Your fellow students can be a great source of help and guidance in your academic endeavors. Consider becoming active with a student organization, such as the following:

- Students in Transportation Engineering and Planning (STEP) / Institute of Transportation Engineers Student Chapter (ITE): step.cecs.pdx.edu
- American Society of Civil Engineers Student Group (ASCE): www.asce.pdx.edu

Most professional organizations have monthly meetings and encourage student participation by providing discounts for lunch and dinner meetings. These meetings provide opportunities to network with potential future employers, learn about scholarships, and increasing your technical knowledge. Take a look at these organizations as a starting point:

- American Society of Civil Engineers (ASCE) Oregon Section: www.asceor.org
- Institute of Transportation Engineers (ITE) Oregon Section: www.oregonite.org
- Society of Women Engineers (SWE) Columbia River Section: www.swe-columbia-river.org
- Structural Engineers Association of Oregon (SEAO): www.seao.org

Research and Learning Opportunities
Transportation is a growing and exciting research area at Portland State University. I invite you to review the research in the Intelligent Transportation Systems Laboratory (www.its.pdx.edu/). Also, every Friday during the semester, a Transportation Seminar is presented at noon. All are welcome. The schedule is available at www.cts.pdx.edu

Campus Help
As a PSU student, you have numerous resources at your disposal. Please take advantage of them while you are here. A small sample is listed below:

- CEE Website (includes program info, job listings, etc.): www.cee.pdx.edul
- Career Center: www.career.pdx.edu/
- Center for Student Health & Counseling: www.shac.pdx.edu/
- The Writing Center: www.writingcenter.pdx.edu/
- PSU Disability Resource Center: 435 Smith Memorial Union Note: The PSU Disability Resource Center is available to help students with academic accommodations. If you are a student who has need for test-taking, note-taking or other assistance, please visit the DRC and notify the instructor at the beginning of the term.

Library and Literature Research
With the advent of the Internet it is very tempting to think that all necessary resources for a term project will

be available in full text after typing in a few words at Google.com. This is not the case. You will often need to go to the library, use real library search tools and access real books and articles contained in refereed/archival journals. Be sure to make use of the Vikat library catalog. Go to the PSU library home page at www.lib.pdx.edu/.

Campus Safety

The University considers student safety paramount. The Campus Public Safety Office is open 24 hours a day to assist with personal safety, crime prevention and security escort services. Call 503-725-4407 for more information. For Campus emergencies call 503-725-4404.

Final Notes

- The syllabus is subject to change at the discretion of the instructor as course or other circumstances require.
- Students with documented disabilities are encouraged to discuss with me arrangements that will enhance their learning in this class.
- If you find you are falling behind in class, please come discuss your concerns with me before they become critical to your success.
- Please feel free to discuss with me problems/concerns with your other classes.

Readings

Read by class on:	***Article/document***
13-Jan	(1) Dixon *et al.* "Balancing urban driveway design demands based on stopping sight distance." *Transportation Research Record No. 2120*. 2009. 18-27. (2) Stinchcombe and Gagnon. "Driving in dangerous territory: Complexity and road-characteristics influence attentional demands." *Transportation Research Part F*. Vol 13. 2010. 388-396. (3) Bellinger *et al.* "The effect of cellular telephone conversation and music listening on response time in braking." *Transportation Research Record Part F*. Vol 12. 2009. 441-451.
20-Jan	(1) Ewing *et al.*, "Urban Design Qualities Related to Walkability." *Journal of Physical Activity and Health*. Vol 3, Suppl 1. 2006. S223-S240. (2) Pucher and Buehler. "Making Cycling Irresistible: Lessons from the Netherlands, Denmark, and Germany." *Transport Reviews*. 2008. 48 p.
27-Jan	No assigned readings (no class)
3-Feb	(1) Cho *et al.* "The role of the built environment in explaining relationships between perceived and actual pedestrian and bicyclist safety." *Accident Analysis and Prevention.* Vol 41. 2009. 692-702. (2) Reynolds *et al*. "The impact of transportation infrastructure on bicycling injuries and crashes: a review of the literature." *Environmental Health*. Vol. 8, Issue 47. 2009. 19p.
10-Feb	(1) Walker and Brosnan. "Drivers' gaze fixations during judgements about a bicyclist's intentions." *Transportation Research Part F*. Vol 10. 2007. 90-98. (2) Turner et al., "Motorist yielding to pedestrians at unsignalized intersections." *Transportation Research Record No. 1982*. 2006. 1-12.
17-Feb	(1) Daniels *et al.*, "Explaining variation in safety performance of roundabouts." *Accident Analysis and Prevention.* Vol 42. 2010. 393-402. (2) FHWA. "Tech Brief: Crosswalk marking field visibility study." FHWA Publication No. FHWA-HRT-10-067. 2010. (3) (*Skim document*) FHWA. *Pedestrian and Bicyclist Intersection Safety Indices: User Guide*. Publication No. FHWA-HRT-06-130. 2007. 62 p.
24-Feb	(1) Fitzpatrick and Park. "Safety Effectiveness of HAWK Pedestrian Treatment." *Transportation Research Record No. 2140*. 2009. 214-223. (2) Lenné et al. "Traffic signal phasing at intersections to improve safety for alcohol-affected pedestrians." *Accident Analysis and Prevention*. Vol 39. 2007. 751-756.

P.O. Box 751
Portland, OR 97207

OTREC is dedicated to stimulating and conducting collaborative multi-disciplinary research on multi-modal surface transportation issues, educating a diverse array of current practitioners and future leaders in the transportation field, and encouraging implementation of relevant research results.