Urban Infrastructure Anatomy and Sustainable Development

Course Syllabus for Spring 2014

SECTIONS

CEE 494	Civil, Environmental, and Sustainability Engineering Undergraduates
CEE 598	Civil, Environmental, and Sustainability Engineering Graduate Students
PUP 598	Planning Graduate Students
SOS 598	School of Sustainability Graduate Students
CEE 486	Civil, Environmental, and Sustainable Engineering Alternative Senior Design Project

INSTRUCTOR

Mikhail Chester
Office ISTB2 239A (enter at 219), email: mchester@asu.edu
Office hours: TBA (or by appointment)

CLASS TIME and LOCATION

Tuesdays and Thursdays, 3:00PM to 4:15PM, LL 102 (Tempe)
January 15, 2014 to April 30, 2014

COURSE WEBSITE

urbansustainability.lab.asu.edu

The credentials for accessing the course website will be provided by email.

PREREQUISITES

CEE 486/494: Civil Engineering BSE students: CEE 321; CEE 341; CEE 351; CEE 361; CEE 372 with C or better. *Or by instructor approval.*

CEE 598, PUP 598, and SOS 598: A willingness to learn about and execute a research project. Need to be comfortable with developing solutions to problems that do not have clear methods for assessment. Need to be comfortable with algebra and conversion of units. Basic physics, chemistry, and linear algebra are helpful, but not needed.

COURSE BACKGROUND and VISION

Understanding how built environment infrastructure systems interact with ecosystem services is a critical foundational element for future engineers who will drive policies and decisions affecting urban sustainability. Sustainable cities can be defined as development that uses materials and energy within the biosphere's capacity for regeneration and waste assimilation. Most contemporary cities operate outside of this criteria. Resources (including food, energy, water, and goods) are shipped in from global logistical networks that shift burdens away from those who use the resources. And dispensing of wastes becomes ever more challenging as siting new landfills is often prohibitive and our concern for

air quality and the climate grows. While our understanding of sustainable transition strategies improves, policy and decision makers continue to support existing practices that sustainable engineers and scientists know cannot continue indefinitely. Historically, engineers have developed infrastructure systems when many sustainability constraints did not exist. This course will provide students with 1) an understanding of the engineering, social, political, community, and economic constraints that affect urban sustainability infrastructure, 2) an enriched educational experience that connects academic principles and theories with practical knowledge, and 3) a vision and desire for developing solutions that transcend the current constraints that engineers face when deploying sustainable infrastructure solutions. The course will focus on Phoenix infrastructure policy and decision making, a city that has expended tremendous resources on growth and water, been largely driven by cheap energy, and with significant access to renewable resources (i.e., solar) and knowledge. By connecting students with regional infrastructure issues, undergraduate students will have the opportunity to understand how fundamental engineering concepts are ultimately applied in sustainable infrastructure decisions, graduate students will be able to test and improve infrastructure sustainability transitional theories and gain insight into governmental processes and jobs that they may ultimately be part of.

COURSE OBJECTIVES

After taking this course students will understand how infrastructure systems are designed and operated, infrastructure systems enable emergent behavior, and urban sustainability transitional strategies can consider the competing technical, economic, social, environmental, political, and community dimensions in strategy development. Students will also learn several systems-oriented analytical frameworks for assessing the sustainability of infrastructure systems.

COURSE OVERVIEW

The course centers on a project that will be developed as a class. In teams, students will develop and analyze urban sustainability transitional strategies for a particular infrastructure component. Students will connect the project theme to other infrastructure systems with the goal of understanding how fundamental engineering, construction, and sustainability design principles fit into complex and interdependent systems. Each week, roughly half of class time will be focused on the project. The remaining time will be used according to the preliminary schedule and topics that follow.

Part 1 – Introduction to Civil Infrastructure Systems. What are infrastructure systems? How have they come to be designed the way they have? How have engineers, planners, architects, and others shaped infrastructure design decisions? There are several core infrastructure systems that provide the foundation for human activities (fossil fuel production and delivery, electricity, buildings, transportation, ICT, etc.). These core infrastructure systems are highly interconnected.

Part 2 – Infrastructure Design and Operation Principles. What are the principle design concepts and operation goals of current infrastructure systems? Do their operations meet societal needs? Will they meet our needs in the future? How do we plan for obsolescence, or technological innovation? Each infrastructure system will be reviewed and discussed.

Part 3 – Sustainability and Development. What are the benefits and costs of infrastructure services? How do we assess the value of infrastructure services? How do we assess capital and operating costs? Where externalities are produced and why? What are the social equity concerns for current and future infrastructure services? How should systems environmental assessment frameworks (i.e., urban metabolism and life cycle assessment) be used to aid transitional strategies?

Part 4 – Policy and Decision Making. The assessment of infrastructure systems should consider the roles of policy and decision makers across diverse disciplines that are not necessarily working in harmony. The course will explore how infrastructure policies and decisions are made, and the incentives and disincentives for interdisciplinary approaches.

TOPICS COVERED

Concepts

- How infrastructure systems work
- Design and operation: past and future
- How decisions are made
- Land use management
- Internal, external, public, & private costs
- Sustainability policy assessment
- Intervention and transitional strategies
- Combustion, air transport, atmospheric chemistry
- NEPA, infrastructure systems, and environmental regulations: sustainability benefits and challenges

Methods

- Urban systems modeling
- Urban metabolism
- Life cycle environmental assessment
- Life cycle cost assessment
- Behavioral and choice modeling
- Optimization for sustainability
- Risk and uncertainty
- Socio-demographic analysis for social equity assessment

EVALUATION for UNDERGRADUATE STUDENTS

1	Class participation	**200**	In-class participation.
2	Attendance	**200**	
3	Reading quizzes	**400**	4 quizzes at 100 each.
4	Homework	**400**	4 assignments at 100 each.
5	Project: Instructor Evaluated Effort	**200**	
6	Project: Effort Assessment by Teammates	**200**	
7	Project: Deliverables	**1,000**	
	➥ Deliverable 1	100	Work plan and data sources.
	➥ Deliverable 2	100	Planned methodology.
	➥ Deliverable 3	200	Summary of preliminary results.
	➥ Deliverable 4	100	Draft final report chapter.
	➥ Deliverable 5	200	Presentation.
	➥ Deliverable 6	300	Final report chapter.
	Total points (1+2+3+4+5+6+7)	**2,600**	

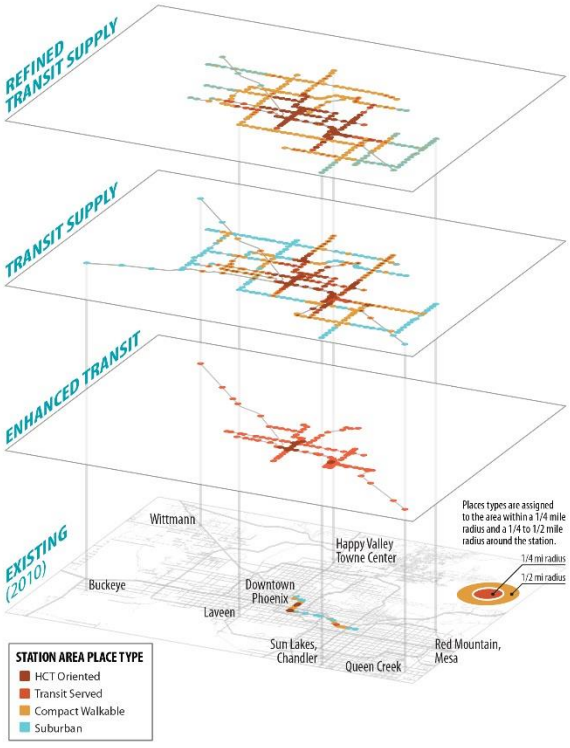
EVALUATION for GRADUATE STUDENTS

1	Class participation	**200**	In-class participation.
2	Attendance	**300**	
3	Reading quizzes	**400**	4 quizzes at 100 each.
4	Homework	**400**	4 assignments at 100 each.
5	Project: Instructor Evaluated Effort	**200**	
6	Project: Effort Assessment by Teammates	**200**	
7	Project: Deliverables	**1,000**	
	➥ Deliverable 1	100	Work plan and data sources.
	➥ Deliverable 2	100	Planned methodology.
	➥ Deliverable 3	200	Summary of preliminary results.
	➥ Deliverable 4	100	Draft final report chapter.
	➥ Deliverable 5	200	Presentation.
	➥ Deliverable 6	300	Final report chapter.
	Total points (1+2+3+4+5+6+7)	**2,700**	

COURSE PROJECT OVERVIEW for SPRING 2014

Background

The Phoenix Light Rail system began operation in 2009 and has experienced higher than forecasted ridership and has created major redevelopment of the core urban area. The line was initially forecast to experience 20,000 trips per day and is currently at 25,000 trips per day. Development along the line has resulted in Phoenix, Tempe, and Mesa rethinking how future growth can happen. The development around the line is expected to result in reductions in energy use, reductions in greenhouse gas emissions, and improvements in air quality. Yet little is known about the co-benefits of this smart growth, particularly how water, electricity, and transportation infrastructure change. As households shift from outlying areas to near light rail, there is an opportunity for greater utilization of existing infrastructure and the avoidance of the development of new infrastructure. If true, these avoided infrastructure costs may be a large co-benefit of high-capacity transit investment.



Project Objective

As a class, we will assess:

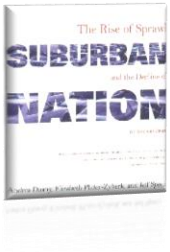
- How do households and businesses that move to near light rail change their water and electricity consumption
- How *water*, *electricity*, and *transportation* infrastructure development could change (is new infrastructure needed for higher density developments near light rail and what is the avoided infrastructure construction from the households and businesses avoiding outward growth).

For each we will assess the physical changes in consumption (i.e., water and electricity), the energy use and air emissions changes, and the cost changes (to both the cities and the users).

Team Structure
The team structures will be decided on January 22. Each team will consist of roughly 3-4 students and will focus on a particular sustainability dimension. The teams are expected to meet outside of class hours and the Project Discussion meetings during class are intended to facilitate interaction between teams.

Deliverable Schedule
The project deliverables specified in the Evaluation sections are designed to ensure that consistent and meaningful progress is made by each team. For Deliverable 1, teams will provide their initial work plan and primary data sources that they will use for their analysis. Deliverable 2 will show the methods that the teams will use to develop their assessment. Deliverable 3 is the initial reporting of results and will give the instructor and teams an opportunity to review and improve their findings before they are finalized. For Deliverable 4, the teams will produce their draft final report chapter which should be based somewhat on Deliverable 2 and 3. Deliverable 5 is the class presentation given to the ASU community and Deliverable 6 is the team final report section.

PRIMARY TEXT



The primary reading is:

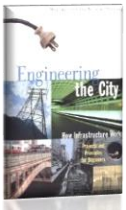
Suburban Nation: The Rise of Sprawl and the Decline of the American Dream
Andres Duany, Elizabeth Plater-Zyberk, and Jeff Speck

Additional readings and resources will be provided via the course website.

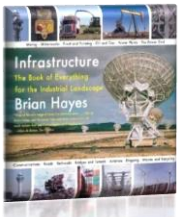
SUPPLEMENTARY TEXTBOOKS

Students may find these supplementary textbooks valuable but they are not required for the course:

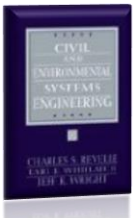
LEVY



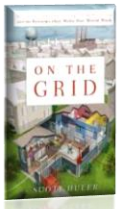
HAYES



REVELLE



HULER



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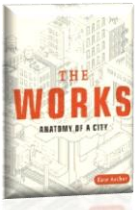

LEVY Levy M and Panchyk R. Engineering the City. ISBN13: 978-1556524196. **HAYES** Hayes B. Infrastructure: A Field Guide to the Industrial Landscape. ISBN13: 978-0393329599. **REVELLE** Revelle C, Whitlatch E E, and Wright J. Civil and Environmental Systems Engineering. ISBN13: 978-0130478221. **HULER** Huler H. On the Grid: A Plot of Land, An Average Neighborhood, and the

Systems that Make Our World Work. ISBN10: 1605296473. **ASCHER** Ascher K. The Works: Anatomy of a City. ISBN13: 978-0143112709.

GRADING

Letter grades will follow the traditional percentage rubric:

- A: 90% to 100% - (minus) 0% to less than 3% within letter
- B: 80% less than 90% + (plus) 7% or greater within letter
- C: 70% to less than 80%
- D: 60% to less than 70%
- F: less than 60%

To receive credit for the class, students must attend all classes (unless the absence is approved by the instructor), participate as an active and contributing group member in the practicum, complete the mid-semester examination, complete the final project, and receive a passing grade on all.

ACADEMIC INTEGRITY

All students are responsible for reviewing and following ASU's policies on academic integrity: http://provost.asu.edu/academicintegrity. If you fail to meet the standards of academic integrity in any of the criteria listed on the university policy website, sanctions will be imposed by the instructor, school, and/or dean. Academic dishonesty includes borrowing ideas without proper citation, copying others' work (including information posted on the internet), and failing to turn in your own work for group projects. Please be aware that if you follow an argument closely, even if it is not directly quoted, you must provide a citation to the publication, including the author, date and page number. If you directly quote a source, you must use quotation marks and provide the same sort of citation for each quoted sentence or phrase. If you have any doubt about whether the form of cooperation you contemplate is acceptable, ask the TA or the instructor in advance of turning in an assignment. Please be aware that the work of all students submitted electronically can be scanned using SafeAssignment, which compares them against everything posted on the internet, online article/paper databases, newspapers and magazines, and papers submitted by other students.

STUDENT SUPPORT and DISABILITY ACCOMMODATIONS

ASU offers support services through Counseling (http://students.asu.edu/counseling), the Learning Resources Center (www.asu.edu/lrc), and the Disability Resource Center (http://www.asu.edu/studentaffairs/ed/drc/). If you are a student in need of special arrangements for we will do all we can to help, based on the recommendations of these services. For the sake of equity for all students, we cannot make any accommodations without formal guidance from these services.