Smart Infrastructures

CE 567
3 Units
Spring 2013

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Course Location and Time:
Room: KAP 134
Tues/Thurs 4:00 - 5:20 pm
Office Hours: By Appointment

"*Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all.*"
– Garrett Hardin, 1968, *The Tragedy of the Commons*

COURSE DESCRIPTION

In Hardin's essay The Tragedy of the Commons, herdsmen, given an open and verdant field, acquire more and more head of cattle, eventually overtaking the capacity of the land to support them. Hardin's parable is meant to illustrate how man often seeks individual benefits even when "society as a whole, of which he is a part, suffers." This underscores the importance of infrastructures as a basic building block of society: To balance the individual's need for light, food, water, transportation and the management of waste – with the systemic needs of society as a whole. Infrastructures support both the private and pubic spheres- life both in the home, and our nation's economy. As such, it is critical they be reliable, safe, and secure - yet increasingly, our infrastructures face both natural and man made risks and challenges, as demonstrated by Hurricane Sandy and the terrorist attacks of 9/11. Our nation's electrical grid is old, and our waterways sorely in need of repair. Societal changes such as population growth and urbanization will strain our highways and leave us dealing with the waste produced in dense urban areas, while the demand for water and energy may outpace supply. These strains point to the need for more sustainable engineering and design, and behavioral changes in lifestyle and consumption patterns. In addition, in a socially connected world, engineering projects which fail to take into account how users might use, accept, or react to new technologies can face blowback and eventual failure, as evidenced by the recent rejection of "smart meters" by large numbers of consumers worldwide, or the "Toilet to Tap" program which failed to persuade users to drink reclaimed water. The take away message from these fail cases is that: to be more successful in their enterprise, those working with infrastructures need to take a complex systems approach, taking into account the technological, social, behavioral, policy, economic, and environmental context. Developing complex infrastructure systems will require new skills and new knowledge bases – in short, the development of a "New Energy Professional" who can traverse these disparate fields. This course will encourage new ways of thinking about infrastructures, to help students consider how to provide people the secure and reliable services and quality of life they desire, while considering the social, political, environmental, business and other impacts.

This course will examine the current status of knowledge about "smart" infrastructures in the principal fields or industries related to energy, water, waste and transportation, taking an interdisciplinary approach by drawing from the fields of engineering, sociology, communications, sustainability and psychology. Students will explore how these infrastructures are being transformed through the intersection of an enriched information technology system, and how an understanding of the social and behavioral aspects of users will help them think about the possibilities for new directions and developments in the future. Lastly, examined will be the impact of these infrastructure systems on the natural environment, including issues around environmental justice and sustainable behaviors.

The course will follow a seminar format, which will include lectures, small group discussion, case studies, films and guest speakers. Students will work in dyads or groups as well as on individual projects, in order to examine the concept of the "smart" infrastructure from a variety of perspectives.

Required Texts:

Hayes, B. (2005). Infrastructure: A Field Guide to the Industrial Landscape W. W. Norton, 2005. ISBN: 978-0393329599

Additional readings on sustainability and infrastructure will be available online on Blackboard or the Distance Learning DEN Blackboard in the Course Documents section.

Course Grading and Assignments:

Each student will be expected to complete three assignments:

1) Reading Summary and Class Discussion Facilitation. Date: TBD
Each week will begin class with a lecture, followed by a discussion where one or two members of the seminar introduce and summarize the readings. These discussions should include some analysis of how the readings fit into the larger themes of the course. Presenters should then initiate the discussion, providing a handout with a minimum of three questions to prompt the discussion.

Distance Learning Students will be able to facilitate a discussion via WebEx. We will discuss the logistics of this this once Webex has been activated for the course.

2) Final Paper. Date: April 30.
Finally, required will be a 15–20 page research paper on a subject related to the themes of the course. If you are unsure about the suitability of a topic, please ask the professor for approval. Final Papers are due December 1 at 5pm, and must be submitted in hard copy to my mailbox in class.

3) Research Paper Option II: Electric Vehicle Charging Infrastructure. Due April 30.
Conventional models of electric vehicle entail a paradigm shift: EV owners would own a piece of the infrastructure, charging their vehicles at home, at night. However – this may not be what people actually do. Also "range anxiety" – the idea that one's electric vehicle might

run out of power while drivers are on the road – has stalled adoption of electric vehicles for some. The Dept. of Energy has said it has no plans to deploy a national electric vehicle charging infrastructure. This issue of a new electric vehicle charging infrastructure needs some consideration. This paper – which will be 7-10 pages – should examine current thinking in this area, citing scholarly research and professional papers on this topic, but then should go further – to include your ideas for solving the problem of an electric vehicle. You should consider the answers to questions such as - Who pays for charging stations? Where should chargers go? What is the model for charging – which takes more time than filling up with gas at the pump? These and other questions and answers should be integrated into a thoughtful analysis in your paper.

4) Infrastructure Lesson plus media ancillary. Date: May 8

STEM education and encouraging students to pursue careers in sciences and engineering has been identified as an important national goal. To address this need, each student will create a lesson on a particular case study of an infrastructure or topic related to this course, targeted at a particular group of students in the K – 12 system, to teach younger students about some aspects of smart infrastructures. Each project should spark an interest in engineering, science or sustainability in these children, and have a clear set of learning objectives for them. The lesson should include an ancillary media component – either a Powerpoint, Prezi, website or film which the teacher or students can use with the lesson. Each student must clearly specify which grade level the lesson is aimed at, and should successfully create a lesson that is age and knowledge level appropriate for the grade level chosen. Students will turn in ancillary materials and an instruction manual for teachers to teach the lesson on May 8th.

Discussion Facilitation	25%
Student Lesson	35%
Final Paper	40%
	100% total

Grading Scale

A 933-1000	A- 900-932	B+ 866-899	B 833-865	B- 800-832	C+ 766-799
C 733-765	C- 700-732	D+ 666-699	D 633-665	D- 600-632	F Below 600

To calculate your grade:

Recalculate everything on a 1000 point scale - For example: The Discussion Facilitation is worth 25% = 250 points. (Student lesson = 350 points; Paper = 400 points). For your total grade, on the 1000 point scale, see Table above.

Class Schedule

January 15

I. Introduction

Introduction to the course, the syllabus. Introduction to professor and each other. Assignments.

January 17
What is Infrastructure?

Aschauer, David Alan, Why is Infrastructure Important, Pg 21-30.

Raymond Williams. Introduction and "Base and Superstructure." in Marxism and Literature. 1978.

January 22
The Tragedy of the Commons, and the Need for Infrastructure
Readings

Hardin, G. (1968). The Tragedy of the Commons. Science.

Dentinho, T. P. (2011). Unsustainable cities, a tragedy of urban infrastructure. Regional Science Policy & Practice. 3(3).

January 24
The Development of Infrastructure
Readings

Jacobsen, C. & Tarr, J. (1996). "No single path Ownership and Financing of Infrastructure in the 19t and 20th Centuries." in Ashoka Mody, Infrastructure Delivery: Private Initiative and the Public Good (Washington, D.C.: The World Bank, 1996), 1-36,

Hughes, T. (1987). "The Evolution of Large Technological Systems." in Bijker, Hughes, and Pinch, eds., The Social Construction of Technological Systems.

January 29
Thinking Systemically: Infrastructures as Complex Systems
Readings

Jean-Marc Offner. "Are There Such Things as Small Networks?" in Coutard, ed. The Governance of Large Technical Systems. 1999.

ASCE (2009). Chapter 4: Employ an integrated systems approach. In Guiding Principles for the Nation's Critical Infrastructure. Reston, VA: ASCE. Available online at: http://tinyurl.com/criticalinfra

January 31
Who pays?: Infrastructure as a Public vs. Private Asset
Readings

Little, R.G. 2010. "Beyond Privatization: Rethinking Private Sector Involvement in the Provision of Civil Infrastructure" in *Physical Infrastructure Development: Balancing the Growth, Equity, and Environmental Imperatives,* W. Ascher and C. Krupp, eds. New York, NY. Palgrave Macmillan.

Little, R.G. 2010. "Towards a New Federal Role in Infrastructure Investment: Using U.S. Sovereign Wealth to Rebuild America." *Public Works Management & Policy,* 14(3):288-306

February 5
The Crisis of a Crumbling Infrastructure

Turner, Daniel 1999. "America's Crumbling Infrastructure." USA Today Magazine 27.

Sanders, H.T. 1993. "What Infrastructure Crisis?" The Public Interest, 110.

February 7
An Introduction to Socio-Technical Systems: Managing Innovation and Change in Organizations
Readings

Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems - Insights about dynamics and change from sociology and institutional theory. Research Policy. 33(6), 897.

February 12
Who's turf?: Policy and Management of Large Socio-Technical Systems

Pisano, M. (2011). Developing the Institutional Capacity to Implement Large-Scale Infrastructure Projects. Public Works Management & Policy. 16(3), 228-239.

February 14
Social groups and Smart Socio-Technical Systems
Readings

Whitworth, B. (2009). The Social Requirements of Technical Systems.
http://brianwhitworth.com/STS/STS-chapter1.pdf

II. Critical Infrastructures

February 19
Power and Energy Infrastructure

Readings

Hayes: Chapter 5: Power Plants

Fox-Penner, P. (2010) "Chapter Two: Deregulation, Past and Prologue." Smart Grids, Smart Power and the future of electric utilities. Washington DC: Island Press.

February 21
Transportation infrastructure
Readings

Hayes: Chapter 8: On the Road

Hayes: Chapter 10: Bridges and Tunnels

February 26
Electric Vehicle Infrastructure
Blackboard: Edison Electric Institute (2009). *Industry Wide Electric Vehicle Market Readiness Pledge.* Available at http://www.eei.org/ourissues/EnergyEfficiency/Documents/PEV_Pledge.pdf.

February 28
Water and Food. Ecological infrastructure
Readings

Hayes: Chapter 2: Waterworks

Hayes: Chapter 3: Food and Farming

March 5
Oil and Gas
Readings

Hayes: Chapter 4: Oil and Gas

Lorenzetti, M. (2001, October). US energy infrastructure security now a key issue in Washington. Oil & Gas Journal, 99(40), 22-26.

March 7
Virtual Infrastructure, Communications and the Networked Society
Readings

Hayes: Chapter 7: Communications

Castells, M. (2000). Prologue and "The Information Technology Revolution." in The Rise of the Network Society. Second edition, 2000.

March 12
Waste

Readings

Hayes: Chapter 13: Wastes and Recycling

Geels, F. & Kemp, R. (2005). Transitions, Transformations and Reproduction: Dynamics in socio-technical systems. Transitions, Transformations and Reproduction: Dynamics in socio-technical systems. Conference Proceedings. DRUID.

III. Challenges:

March 14
Population Growth and the Environment: The Malthusian Argument
Readings

Bell, M. (2009). "Population and Development." In An Invitation to Environmental Sociology, Pine Forge Press, pp. 85-109.

March 18-23: Spring Break

March 26
The Risk of Global Climate Change
Readings

EPA (2009). Frequently Asked Questions About Global Warming and Climate Change: Back to Basics. Retrieved from: http://www.epa.gov/climatechange/downloads/Climate_Basics.pdf.

March 28
Seeking Safety: Terrorist Threats, Vulnerability and Resilience in Smart Socio-Technical Systems
Readings

Winner, L. (2004). Trust and terror: the vulnerability of complex socio-technical systems. Science As Culture. 13(2), 155-172.

Egan, M. J. (2007). Anticipating Future Vulnerability: Defining Characteristics of Increasingly Critical Infrastructure-like Systems. Journal of Contingencies and Crisis Management. 15(1), 4-17.

IV. Case Examples

April 2
The Smart Grid: Demand Response Technologies
Readings

Hayes: Chapter 6: The Power Grid

Simmhann, et al. (2011) An informatics approach to demand response optimization in smart grids. Technical Report, Under Preparation.

April 4
Toilet to Tap: Transforming Waste into Clean Energy and Water, and the Trouble with Perception
Readings

Antholz, M. et al (2009). Domestic Wastewater Recycling: "Toilet-to-toilet" and "tap-to-tap", instead of "toilet-to-tap" - A new approach. Das Gas- und Wasserfach, pp. 80-92.

April 9
Smart Community Models: Community Wind and Solar Safety Nets
Readings

Cowell, R., Bristow, G., & Munday, M. (2011). Acceptance, acceptability and environmental justice: the role of community benefits in wind energy development. Journal of Environmental Planning and Management. 54(4), 539-557.

April 11
Social influence Using Virtual Systems: Social Media and Energy Conservation
Readings

McCalley, L., de Vries, P., & Midden, C. J. H. (2011). Consumer Response to Product-Integrated Energy Feedback: Behavior, Goal Level Shifts, and Energy Conservation. Environment and Behavior. 43(4), 525-545.

V. Emerging Issues:

April 16
Consumption and the Middle Class Lifestyle
Readings

Bell, M. (2009). "Consumption and materialism." In An Invitation to Environmental Sociology, Los Angeles: Pine Forge Press, pp. 33- 56.

April 18
Sustainability and Energy Conservation Behaviors
Readings

Gardner, G., & Stern, P.. (2008). The Short List: The Most Effective Actions U.S. Households Can Take to Curb Climate Change. Environment, 50(5), 12-24.

April 23
Diminishing resources: Population Changes and the food-water-energy nexus
Readings

Scott, Z. R., Scott, Z. R., Scott, Z. R., Scott, T. J., Scott, T. J., Scott, T. J., Gonzalez, D. O., Gonzalez, D. O., Gonzalez, D. O., Gonzalez, D. O., & Moe, T. L. (2010). Will Limited Land,

Water, and Energy Control Human Population Numbers in the Future? Human Ecology. 38(5), 599-611.

April 25
Environmental Justice
Readings

Cox R. (2010). "Environmental Justice/ Climate Justice" In Environmental Communication and the Public Sphere. Los Angeles: Sage, pp. 263-296.

April 30
Lessons Learned: Blowback, Risks and Reactions to a Smart Society
Student Papers Due
Readings

DOE Case Study Interview: Con Edison New York
Demand Response Lessons Learned
http://www.demandresponsesmartgrid.org/Default.aspx?pageId=1409851

Audio interview available here:
http://tinyurl.com/conedtalk

April 30
Wrapping Up, and thinking about the future of Smart Infrastructures

Hayes: Afterword: The Postindustrial Landscape

The reality of cyber-terrorism: The Stuxnet worm is a blueprint for future infrastructure attacks. (2010). IET Engineering & Technology. (17), 36.

May 8

Final Exam: Presentation of Student Lesson Project