

**University of Southern California**  
**Sonny Astani Department of Civil and Environmental Engineering**

**CE 515 - Sustainable Infrastructure Systems**

**Course Syllabus - Fall 2013**

While open to many different interpretations, “sustainability” generally implies the optimization of economic, environmental, and social factors when developing complex infrastructure systems. CE 515 shows students how to create dynamic infrastructure models, how to include economic, environmental, and social attributes, and how to assess behavior under disruptive perturbations. Students will use these skills to evaluate an infrastructure system of their choice.

**Course Administration**

CE 515 generally meets on Tuesdays and Thursdays from 5:00 - 6:20 for lectures or discussion. However, some of the Thursday classes take the form of prerecorded lectures that are available on BlackBoard via the DEN website: [gapp.usc.edu](http://gapp.usc.edu)

The last day to drop the class without a W grade is 13 September, and the last day to drop the class with a W grade is 15 November. Incomplete grades (IN) are rarely assigned. This grade may be justified only in exceptional cases such as student illness or a personally tragic event occurring after the twelfth week of the semester.

The CE 515 grade is based on the following components:

Homework	(4)	20%
Short Papers	(4)	20%
Term Project		60%

There are no midterm or final exams. The CE 515 term project involves the simulation of a simple infrastructure system of interest to a team using standard Systems Dynamics software. Up to four students per team is permitted. Teams are required to present their work.

Once assigned, the CE 515 letter grade will be final except for grossly erroneous circumstances. Your grade cannot be changed via additional work --- don't even ask.

**Instructor Information**

Edward W. Maby    PHE 626    0-4706    [maby@usc.edu](mailto:maby@usc.edu)  
Office Hours: TTh 1:00 - 2:00

Nima Jabbari (Teaching Assistant)    [jabbari@usc.edu](mailto:jabbari@usc.edu)  
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## Tentative CE 515 Schedule - Fall 2013

### Color Code

Black In-class lecture or discussion topic (Tuesday or Thursday, 5:00 p.m.)

Red On-line lecture topic(s) - View prior to next Tuesday class

Blue Required readings

Green Recommended supplementary readings

### Textbooks Cited

*Thinking in Systems*, Donella Meadows

*Modeling the Environment* (2E), Andrew Ford

### Week 1 -

27 August

What is infrastructure? - What is sustainability? - What are systems?

Poorly sustained example

ASCE Report Card

(Andrew Herrmann)

The Meaning of Sustainability

(Panel discussion)

*Sustainability: An Economist's Perspective* - Solow

*Creating the Future We Want* - Hecht et al.

Response - Stutz

Rejoinder - Hecht et al.

*Is Sustainability Sustainable?* - Bonevac

*Infrastructure: A Field Guide to the Industrial Landscape* - Hughes

OECD: *Infrastructure to 2030* (2006)

ASCE Report Card (2009) - [www.asce.org/reportcard](http://www.asce.org/reportcard)

2013 Sustainable Electricity Annual Report - Canadian Electricity Association

*The Limits to Growth and the limits to computer modeling* - Hughes

*Environmental Alarmism, Then and Now* - Lomborg

Assignment: Personal introduction and sustainability perspective paper - Due 6 September

## Week 2 -

3 September

Introduction to System Dynamics

(Greg Hennessey)

*Meadows: Introduction, Chapters 1 and 2*

*Ford: Chapters 1 - 5*

*A Skeptic's Guide to Computer Models - Sterman*

5 September

Systems dynamics software. Examples featuring feedback and/or delay.

*Oscillating Systems II: Sustained Oscillation - Agatstein*

Assignment: System dynamics exercises - Due 13 September

## Week 3 -

10 September

Stocks and Flows - Water

*Global Hydrological Cycles and World Water Resources - Oki and Kanae*

*Groundwater in Peril - Jones*

*Water and Energy Interactions - McMahon and Price*

12 September

Stocks and Flows II - Energy

*Stocks, Flows, and Prospects of Energy - Löschel et al.*

*Energy Intensity of Agriculture and Food Systems - Pelletier et al.*

*Another Inconvenient Truth: How Biofuel Policies are Deepening Poverty and Accelerating Climate Change - Oxfam International*

*Linkages of Sustainability - Graedel and van der Voet (Highly recommended)*

Assignment: Team composition and tentative project abstract - Due 20 September

## Week 4 -

17 September

System Dynamics Modeling - Scope, Precision, Mapping (Greg Hennessey)

*Meadows: Chapters 3 and 4*

*Ford: Chapters 6 - 9, Appendix A*

*Mistakes and Misunderstandings: Examining Dimensional Inconsistency - Gary*

19 September

Model Development - Sustainia 1 (Population Dynamics)

*The Development and Use of Demographic Models - Coale and Trussell*

*A Concise History of World Population (4E) - Livi-Bacci*

Assignment: System dynamics exercises - Due 27 September

## Week 5

24 September

Environmental Pillar of Sustainability (Speaker TPD)

*Infrastructure and the Environment - Doyle and Havlik*

Other Required Readings TBD

Environmental Compliance (Shilpa Gupta)

*America's Environmental Report Card - Blatt*

*The Skeptical Environmentalist: Measuring the State of the Real World - Lomborg*

*Something New Under the Sun: An Environmental History of the Twentieth-Century World - McNeil*

Assignment: Environmental sustainability paper - Due 4 October

## **Week 6**

1 October

System Dynamics Modeling - Traps, Uncertainties, Boundaries (Greg Hennessey)

[Meadows: Chapter 5](#)

[Ford: Chapters 10 - 12](#)

[Reflections on the Foundations of Systems Dynamics - Richardson](#)

3 October

Model Development - Sustainia 2 (Environmental Overlay)

*A Systems Dynamics Model to Facilitate Public Understanding of Water Management Options in Las Vegas, Nevada - Stave*

Assignment: System dynamics exercises - Due 11 October

## **Week 7**

8 October

Economic Pillar of Sustainability

(Charles Cicchetti)

[Required Readings TBD](#)

10 October

Sustainable Finance

(Wayne Kalayjian)

[Required Readings TBD](#)

Assignment: Economic sustainability paper - Due 18 October

## **Week 8**

15 October

System Dynamics Modeling - Leverage Points, Pitfalls

(Greg Hennessey)

[Meadows: Chapter 6](#)

[Ford: Chapters 13, 14, and 17, Appendix D](#)

[Ford: Chapters 15 and 16](#)

17 October

Model Development - Sustainia 3 (Economic Overlay)

Assignment: System dynamics exercises - Due 25 October

## **Week 9**

22 October

Social Pillar of Sustainability

(Julie Albright)

*A Missing Pillar? Challenges in Theorizing and Practicing  
Social Sustainability* - Böstrom

[Environmental Justice](#) - Mohai et al.

[Environmental Justice](#) - Ramo et al.

24 October

Sustainability Ethics

(Julie Albright)

[Required Readings TBD](#)

Assignment: Social-issues sustainability paper - Due 1 November

## Week 10

29 October

System Dynamics Modeling - Actors

(Greg Hennessey)

[Required Readings TBD](#)

31 October

Model Development - Sustainia 4 (Social Overlay)

**Student projects and teams should be well undersay. Changes to the scope of the team project must be submitted to the course instructor for approval no later than 8 November.**

## Week 11

5 November

Infrastructure Risk

(Richard Little)

[\*Organizational Aspects of Failures in Large Technical Systems - Little\*](#)

[\*Managing the Risk of Cascading Failure in Complex Urban Infrastructures - Little\*](#)

7 November

Infrastructure Resilience

(Azad Madni)

[\*Towards a Conceptual Framework for Resilience Engineering - Madni\*](#)

[\*Designing Resilient Sustainable Systems - Fiksel\*](#)

Assignment: Project progress report - Due 15 November

## Week 12

12 November

Systems Dynamics Example -

(Andrew Ford)

*Simulating the Value of Advanced Electricity Storage: Initial Results from a Case Study of the Ontario Power System - Ford*

Systems Dynamics Example - CO<sub>2</sub> model

(Andrew Ford)

Ford: Chapter 23

*Simulation Scenarios for Rapid Reduction in Carbon Dioxide Emissions in the Western Electricity Region - Ford*

## Week 13

19 November

Sustainability Metrics

*Indicators for Sustainable Development: Theory, Method, Applications - Bossel*  
*Indicators and Information Systems for Sustainable Development - Meadows*

21 November

Risk and Resilience

(Richard Little)

*What to Do While the Water Rises - Little*

*Re-engineering Cities: A Framework for Adaption to Global Change - Dawson*

*Integrating Risk and Resilience Approaches to Catastrophe Management in Engineering Systems - Park et al.*

## Week 14

Thanksgiving Week - No Class

## Week 15

3 December and 5 December

Class Presentations

## **Textbooks (Required)**

Donella H. Meadows, *Thinking in Systems: A Primer* (Chelsea Green, 2008).

Andrew Ford, *Modeling the Environment* (2E), (Island Press, 2010).

## **Recommended Texts**

### Sustainability

Simon Bell and Stephen Morse, *Measuring Sustainability: Learning from Doing* (Earthscan, 2006)

Simon Bell and Stephen Morse, *Sustainability Indicators: Measuring the Immeasurable* (Earthscan, 2008)

John Blewitt, *Understanding Sustainable Development* (Earthscan, 2008).

Robert Costanza, Lisa J. Graumlich, and Will Steffin, *Sustainability or Collapse: An Integrated History and Future of People on Earth* (MIT, 2007).

Stephen Cohen, *Sustainability Management: Lessons from and for New York City, America, and the Planet* (Columbia, 2011).

Jared Diamond, *Collapse: How Societies Choose to Fail or Succeed* (Viking, 2005).

Thomas Graedel and Ester van der Voet, *Linkages of Sustainability* (MIT, 2010).

John R. Ehrenfeld, *Sustainability by Design* (Yale, 2008).

Joan Fitzgerald, *Emerald Cities: Urban Sustainability and Economic Development* (Oxford, 2010).

Richard Heinberg and Daniel Lerch (eds.), *The Post Carbon Reader: Managing the 21st Century's Sustainability Crisis* (Watershed Media, 2010).

Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, and William W. Behrens III, *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind* (Universe Books, 1972).

Donella H. Meadows, Jorgen Randers, and Dennis L. Meadows, *Limits to Growth: The 30-Year Update* (Chelsea Green, 2004).

Adrian Parr, *Hijacking Sustainability* (MIT, 2009)

Jorgen Randers, *2052: A Global Forecast for the Next Forty Years* (Chelsea Green, 2012).

Peter Rogers, Kazi Jalal, and John Boyd, *An Introduction to Sustainable Development* (Earthscan, 2008)

Andrew Ross, *Bird on Fire: Lessons from the World's Least Sustainable City* (Oxford, 2011).

Joseph A. Tainter, *The Collapse of Complex Societies* (Cambridge, 1988).

Catherine Tumbler, *Small, Gritty, and Green: The Promise of America's Smaller Industrial Cities in a Low-Carbon World* (MIT, 2012).

Robert W. Taylor, *Taking Sides: Clashing Views in Sustainability* (McGraw-Hill, 2012).

Brian Tilt, *The Struggle for Sustainability in Rural China: Environmental Values and Civil Society* (Columbia, 2010).

### Infrastructure (General)

Kate Ascher, *The Works: Anatomy of a City* (Penguin, 2005).

Stephen Graham (ed.), *Disrupted Cities: When Infrastructure Fails* (Routledge, 2010).

Harry Granick, *Underneath New York* (Fordham, 1991).

Brian Hayes, *Infrastructure: A Field Guide to the Industrial Landscape* (Norton, 2005).

Alex Marshall, *Beneath the Metropolis: The Secret Lives of Cities* (Carroll and Graf, 2006).

Julia Solis, *New York Underground: The Anatomy of a City* (Routledge, 2005).

Kazys Varnelis (ed.), *The Infrastructural City: Networked Ecologies in Los Angeles* (Actar, 2009).

### Electric Power

Charles Coleman, *P. G. and E. of California: The Centennial Story of Pacific Gas and Electric Company* (McGraw-Hill, 1952).

Ernest Freeberg, *The Age of Edison: Electric Light and the Invention of Modern America* (Penguin, 2013).

Richard F. Hirsh, *Technology and Transformation in the American Electric Utility Industry* (Cambridge, 1989).

Richard F. Hirsh, *Power Loss: The Origins of Deregulation and Restructuring in the American Electric Utility System* (MIT, 1999).

Thomas P. Hughes, *Networks of Power: Electrification in Western Society* (Johns Hopkins, 1983).

Richard Munson, *From Edison to Enron: The Business of Power and What It Means for the Future of Electricity* (Praeger, 2005).

William A. Myers, *Iron Men and Copper Wires: A Centennial History of the Southern California Edison Company* (Trans-Anglo Books, 1984).

David E. Nye, *When the Lights Went Out: A History of Blackouts in America* (MIT, 2010).

### Water

Shimon C. Anisfeld, *Water Resources* (Island Press, 2010).

David P. Billington and Donald C. Jackson, *Big Dams of the New Deal Era* (Oklahoma, 2006).

Kevin Bone (ed.), *Water Works: The Architecture and Engineering of the New York City Water Supply* (Monacelli Press, 2006).

Peter Brown and Jeremy Schmidt, *Water Ethics: Foundational Readings for Students and Professionals* (Island Press, 2010).

David Carle, *Introduction to Water in California* (California, 2009).

William deBuys and Joan Myers, *Salt Dreams: Land and Water in Low-Down California* (University of New Mexico Press, 1999).

Diane Galusha, *Liquid Assets: A History of New York City's Water System* (Purple Mountain, 1999).

Blake Gumprecht, *The Los Angeles River: Its Life, Death, and Possible Rebirth* (Johns Hopkins, 1999).

Norris Hundley, Jr., *The Great Thirst: Californians and Water, 1770s - 1990s* (California, 1992).

William Kahrl, *Water and Power* (University of California Press, 1982).

Gerard T. Koeppe, *Water for Gotham: A History* (Princeton, 2000).

George Kuffner (ed.), *The Power of Water* (DVA, 2006).

Daniel McCool, *River Republic: The Fall and Rise of America's Rivers* (Columbia, 2012).

Patrick McCully, *Silenced Rivers: The Ecology and Politics of Large Dams* (Zed Books, 1996).

John Opie, *Ogallala: Water for a Dry Land* (University of Nebraska Press, 1993).

Jared Orsi, *Hazardous Metropolis: Flooding and Urban Ecology in Los Angeles* (California, 2004).

James Powell, *Lake Powell: Global Warming, and the Future of Water in the West* (University of California Press, 2008).

Peter Rogers, *America's Water: Federal Roles and Responsibilities* (MIT, 1993).

James Salzman, *Drinking Water: A History* (Overlook Duckworth, 2012).

Andrew Sansom, *Water in Texas: An Introduction* (Texas, 2008).

David Soll, *Empire of Water: An Environmental and Political History of the New York Water Supply* (Cornell, 2013).

Steven Solomon, *Water: The Epic Struggle for Wealth, Power, and Civilization* (Harper Collins, 2010).

Donald Worster, *Rivers of Empire: Water, Aridity & the Growth of the American West* (Pantheon, 1985)

### Transportation

H. Roger Grant, *Railroads and the American People* (University of Indiana Press, 2012).

Clifton Hood, *722 Miles: The Building of the Subways and How They Transformed New York* (Simon & Schuster, 1993).

William Kaszynski, *The American Highway* (McFarland, 2000).

Albro Martin, *Railroads Triumphant: The Growth, Rejection & Rebirth of a Vital American Force* (Oxford, 1992).

Bill Sharpsteen, *The Docks* (California, 2011).

Richard Sanders, Jr., *Merging Lines: American Railroads, 1900-1970* (Northern Illinois, 2001).

Richard Sanders, Jr., *Main Lines: Rebirth of the North American Railroads, 1970-2002* (Northern Illinois, 2001).

Vaclav Smil, *Prime Movers of Globalization: The History and Impact of Diesel Engines and Gas Turbines* (MIT, 2010).

James E. Vance, Jr., *The North American Railroad: Its Origin, Evolution, and Geography* (Johns Hopkins, 1995).

Christopher Wells, *Car Country: An Environmental History* (University of Washington Press, 2012).

Christian Wolmar, *The Great Railway Revolution: The Epic Story of the American Railroad* (Atlantic Books, 2012).

### Telecommunications

Richard R. John, *Network Nation: Inventing American Telecommunications* (Harvard, 2010).

Jonathan E. Nuechterlein and Philip J. Weiser, *Digital Crossroads: American Telecommunications Policy in the Internet Age* (MIT, 2005).

Kazys Varnelis (ed.), *Networked Publics* (MIT, 2008).

Brian Winston, *Media, Technology, and Society, a History: From the Telegraph to the Internet* (Routledge, 1998).

Tim Wu, *The Master Switch: The Rise and Fall of Information Empires* (Knopf, 2010).

### Energy

Peter Asmus, *Introduction to Energy in California* (California, 2009).

Charles Cicchetti, *Going Green and Getting Regulation Right: A Primer for Energy Efficiency* (Public Utilities Reports, 2009).

David Ginsley and David Cahen (eds.), *Fundamentals of Materials for Energy* (Cambridge, 2012).

Michael J. Graetz, *The End of Energy: The Unmaking of America's Environment, Security, and Independence* (MIT, 2011).

Amory B. Lovins, *Reinventing Fire: Bold Business Solutions for the New Energy Era* (Chelsea Green, 2011).

David J. C. MacKay, *Sustainable Energy: Without the Hot Air* (UIT, 2009).

David E. Nye, *Consuming Power: A Social History of American Energies* (MIT, 2001).

Vaclav Smil, *Energies: An Illustrated Guide to the Biosphere and Civilization* (MIT, 1999).

Vaclav Smil, *Energy at the Crossroads: Global Perspectives and Uncertainties* (MIT, 2003).

Peter F. Smith, *Sustainability at the Cutting Edge: Emerging Technologies for Low-Energy Buildings* (Architectural Press, 2003).

Jefferson W. Tester, Elisabeth M. Drake, Michael J. Driscoll, Michael W. Golay, and William A. Peters, *Sustainable Energy: Choosing Among Options* (MIT, 2005).

James C. Williams, *Energy and the Making of Modern California* (Akron, 1997).

Daniel Yergin, *The Quest: Energy, Security, and the Remaking of the Modern World* (Penguin, 2011).

## Environment

Harvey Blatt, *America's Environmental Report Card: Are We Making the Grade?* (MIT, 2011).

David Carle, *Introduction to Air in California* (California, 2006).

David Carle, *Introduction to Earth, Soil, and Land in California* (California, 2010).

Jason Clay, *World Agriculture and the Environment* (Island Press, 2004).

Annie Leonard, *The Story of Stuff: How Our Obsession with Stuff is Trashing the Planet, Our Communities, and Our Health --- and a Vision for Change* (Free Press, 2010).

Bjorn Lomborg, *The Skeptical Environmentalist: Measuring the Real State of the World* (Cambridge, 2001).

Bjorn Lomborg, *Smart Solutions to Climate Change: Comparing Costs and Benefits* (Cambridge, 2010).

J. R. McNeill, *Something New Under the Sun: An Environmental History of the Twentieth-Century World* (Norton, 2000).

Norman Myers (ed.), *Gaia: An Atlas of Planet Management* (Anchor Press, 1984).

Clive Ponting, *A New Green History of the World* (Penguin, 2007).

Joachim Radkau, *Nature and Power: A Global History of the Environment* (Cambridge, 2008).

Vaclav Smil, *The Earth's Biosphere: Evolution, Dynamics, and Change* (MIT, 2002).

Vaclav Smil, *Harvesting the Biosphere: What We Have Taken From Nature* (MIT, 2013).

### Systems Dynamics and Engineering Systems

Hartmut Bossel, *Modeling and Simulation* (A. K. Peters, 1994).

Hartmut Bossel, *Systems and Models: Complexity, Dynamics, Evolution, Sustainability* (Books on Demand, 2007).

Hartmut Bossel, *System Zoo 1 Simulation Models: Elementary Systems, Physics, Engineering* (Books on Demand, 2007).

Hartmut Bossel, *System Zoo 2 Simulation Models: Climate, Ecosystems, Resources* (Books on Demand, 2007).

Hartmut Bossel, *System Zoo 3 Simulation Models: Economy, Society, Development* (Books on Demand, 2007).

Anthony Clyton and Nicholas Radcliffe, *Sustainability: A Systems Approach* (Earthscan, 1996).

Dietrich Dörner, *The Logic of Failure: Recognizing and Avoiding Error in Complex Situations* (Basic Books, 1989).

John Morecroft, *Strategic Modeling and Business Dynamics* (Wiley, 2007)

John D. Sterman, *Systems Thinking and Modeling for a Complex World* (McGraw-Hill, 2000).

Olivier L. de Weck, Daniel Roos, and Christopher Magee, *Engineering Systems: Meeting Human Needs in a Complex Technological World* (MIT, 2012).