

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

**CE 515 - Sustainable Infrastructure Systems**

**Course Syllabus - Fall 2014**

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 3:30 - 4:50 for lectures or discussion. A few classes will take the form of prerecorded lectures that are available on BlackBoard via the DEN website: [gapp.usc.edu](http://gapp.usc.edu) See the syllabus for times.

The last day to drop the class without a W grade is 12 September, and the last day to drop the class with a W grade is 14 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:

Short Papers	(5)	25%
Homework	(5)	25%
Term Project		50%

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 606    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)  
Babak Zareian (Teaching Assistant)    [zareian@usc.edu](mailto:zareian@usc.edu)

## Tentative CE 515 Schedule - Fall 2014

### Color Code

Black In-class lecture or discussion topic (Tuesday or Thursday, 3:30 p.m.)

Blue Required readings

Green Recommended supplementary readings

### Textbooks Cited

*Thinking in Systems*, Donella Meadows

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

### Week 1 -

26 August

What is infrastructure? - What is sustainability? - What are systems?  
Poorly sustained example

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

*Sustainability: An Economist's Perspective* - Solow

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

Response - Stutz

Rejoinder - Hecht et al.

*Is Sustainability Sustainable?* - Bonevac

*Limits to Growth: The 30-Year Update* - Meadows et al.

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

*Environmental Alarmism, Then and Now* - Lomborg

28 August

Introduction to System Dynamics (Greg Hennessey)

Meadows: Introduction, Chapter 1

Ford: Chapter 1

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

Assignment: Personal introduction and sustainability perspective paper - Due 5 September

## Week 2 -

2 September

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

Meadows: Chapter 2

Ford: Chapters 2 - 4

*Generic Structures in Oscillating Systems I* - Chung

*Oscillating Systems II: Sustained Oscillation* - Agatstein

*Properties of Damped Oscillations Systems* - Zhu

4 September

Infrastructure Report Card for Los Angeles County (Yazdan Emrani, ASCE)

*Report Card for Los Angeles County Infrastructure: A Citizen's Guide* (2012)

*ASCE Report Card for America's Infrastructure* (2013)

- <http://www.infrastructurereportcard.org>

*Sustainable Electricity Annual Report* (2013) - Canadian Electricity Association

**Assignment: System dynamics exercises - Due 13 September**

## Week 3 -

9 September

Stocks and Flows - Water (Energy, Land Use, and Nonrenewable Resources)

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

*Groundwater in Peril* - Jones

*Water and Energy Interactions* - McMahon and Price

11 September

Stocks and Flows II - Energy (Water, Land Use, and Nonrenewable Resources)

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

*On the Sustainability of Renewable Energy Sources* - Edenhofer et al.

*Stocks, Flows, and Prospects of Land* - Seto et al.

*Stocks, Flows, and Prospects of Mineral Resources* - MacLean et al.

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

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

#### **Week 4 -**

*16 September*

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

Meadows: Chapters 3 and 4

Ford: Chapters 5 and 6, Appendix A

*Mistakes and Misunderstandings: Examining Dimensional Inconsistency* - Gary

*18 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 26 September**

#### **Week 5**

*23 September*

Environmental Pillar of Sustainability (Speaker TPD)

*Infrastructure and the Environment* - Doyle and Havlik

*25 September*

Environmental Compliance (Shilpa Gupta, LADWP)

*Engaging Overburdened Communities in Permitting Actions:*

*US Environmental Protection Agency's "Promising Practices" to Promote Environmental Justice* - Forrest

*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 3 October**

## **Week 6**

*30 September*

System Dynamics Modeling - System Archetypes and Traps (Greg Hennessey)

Meadows: Chapter 5

Ford: Chapters 9, 11

*Reflections on the Foundations of Systems Dynamics* - Richardson

Ford: Chapters 7 and 8

*2 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**

*7 October*

Economic Pillar of Sustainability (Charles Cicchetti)

*Thirty Years of Economics at the Environmental Protection Agency* - McGartland

*Assessing the Cost of Regulatory Proposals for Reducing Greenhouse*

*Gas Emissions* - Aldy

*Duke's Fifth Fuel* - Cicchetti

9 October

Sustainable Finance (Wayne Kalayjian)

Required Readings TBD

Assignment: Economic sustainability paper - Due 17 October

## Week 8

14 October

System Dynamics Modeling - Modeling Process and Validation (Greg Hennessey)

Ford: Chapters 13, 14, and 17

Ford: Chapters 15 and 16

16 October

Model Development - Sustainia 3 (Economic Overlay)

Assignment: System dynamics exercises - Due 25 October

## Week 9

21 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.

23 October

Sustainability Ethics (Julie Albright)

Required Readings TBD

Assignment: Social-issues sustainability paper - Due 1 November

## Week 10

28 October

System Dynamics Modeling - Uncertainty, Sensitivity, and Intervention (Greg Hennessey)

Meadows: Chapters 6 and 7

Ford: Chapters 18, 19, Appendix D

30 October

Model Development - Sustainia 4 (Social Overlay)

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

## Week 11

4 November

Managing the Risk of Cascading Failure in Interdependent Infrastructures (Richard Little)

*Toward More Robust Infrastructure: Observations on Improving the Resilience and Reliability of Critical Systems - Little*

*The Role of Organizational Culture and Values in the Performance of Critical Infrastructure Systems - Little*

*The Logic of Failure - Dorner*

*Towards a Conceptual Framework for Resilience Engineering - Madni*

6 November

Adapting to Climate Change: Preparing the Flood-Resilient City (Richard Little)

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

*What to Do While the Water Rises - Little*

*Designing Resilient Sustainable Systems - Fiksel*

**Assignment: Project progress report - Due 15 November**

**Week 12**

*11 November*

Maintaining Vital Systems: A Stock and Flow Approach to Infrastructure Services  
(Richard Little)

*Tending the Infrastructure Commons: Ensuring the Sustainability of Our Vital  
Public Systems - Little*

*The Role of Asset Management in Reducing the Risk of Catastrophic Infrastructure  
Failure - Little*

*13 November*

Sustainability Isn't Free: Revenue and Financing Options for Infrastructure (Richard Little)

*A Sustainable Funding and Financing Strategy for Urban Infrastructure Renewal  
in China - Little*

*Toward a New Federal Role in Infrastructure Investment: Using U.S. Sovereign Wealth  
to Rebuild America - Little*

**Assignment: Infrastructure Risk and Resilience Paper - Due 21 November**

**Week 13**

*18 November*

Sustainability Metrics

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

*20 November*

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*

Assignment: System Dynamics Exercises - Due 1 December

**Week 14**

Thanksgiving Week - No Class

**Week 15**

*2 December*            Class Presentations

*4 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).

Bert J. M. de Vries, *Sustainability Science* (Cambridge, 2013).

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).

Paul L. Knox and Heike Mayer, *Small-Town Sustainability: Economic, Social, and Environmental Innovation* (2E, Birkhauser, 2013).

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

Tony Allan, *Virtual Water* (I. B. Taurus, 2011).

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).

Brahma Chellaney, *Water: Asia's New Battleground* (Georgetown, 2011).

Juliet Christian-Smith and Peter H. Gleick, *A Twenty-First Century U. S. Water Policy* (Oxford, 2012).

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).

Philip Garone, *The Fall and Rise of the Wetlands of California's Great Central Valley* (California, 2011).

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

Abraham Hoffman, *Mono Lake: From Dead Sea to Environmental Treasure* (New Mexico, 2014).

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

William L. Kahrl, *The California Water Atlas* (State of California, 1978).

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

Gerard T. Koepfel, *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).

Steven Mithen, *Thirst: Water and Power in the Ancient World* (Harvard, 2012).

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, *Dead Pool: Lake Powell, Global Warming, and the Future of Water in the West* (California, 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 Sedlak, *Water 4.0* (Yale, 2014).

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)

### Waste Management

Samantha MacBride, *Recycling Reconsidered: The Present Failure and Future Promise of Environmental Action in the United States* (MIT, 2013).

Martin U. Melsoi, *The Sanitary City: Environmental Services in Urban America from Colonial Times to the Present* (Pittsburgh, 2008).

Heather Rogers, *Gone Tomorrow: The Hidden Life of Garbage* (New Press, 2005).

### Transportation

Ethan N. Elkind, *Railtown: The Fight for the Los Angeles Metro Rail and the Future of the City* (California, 2014).

Robert E. Gallamore and John R. Meyer, *American Railroads: Decline and Renaissance in the Twentieth Century* (Harvard, 2014).

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).

Joseph B. Raskin, *The Routes Not Taken: A Trip Through New York City's Unbuilt Subway System* (Fordham, 2014).

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).

Christopher F. Jones, *Routes of Power: Energy and Modern America* (Harvard, 2014).

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).

### Urban Systems

Shlomo Angel, *Planet of Cities* (Lincoln Institute, 2012).

Michael Batty, *The New Science of Cities* (MIT, 2013).

Paulo Ferrao and John E. Fernandez, *Sustainable Urban Metabolism* (MIT, 2013).

Richard T. T. Forman, *Urban Ecology: The Science of Cities* (Cambridge, 2014).

Karen C. Seto and Anette Reenberg, *Rethinking Global Land Use in an Urban Era* (MIT, 2014).

P. D. Smith, *City: A Guidebook for the Urban Age* (Bloomsbury, 2012).

Emily Talen, *City Rules: How Regulations Affect Urban Form* (Island Press, 2012).

Austin Troy, *The Very Hungry City: Urban Energy Efficiency and the Economic Fate of Cities* (Yale, 2012).

### 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).

Mark Elvin, *An Environmental History of China* (Yale, 2004).

Paul Josephson, Nicolai Dronin, Ruben Mnatsakanian, Aleh Cherp, Dmitry Efremenko, and Valdislav Larin, *An Environmental History of Russia* (Cambridge, 2013).

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).

Ted Steinberg, *Gotham Unbound: The Ecological History of Greater New York* (Simon and Schuster, 2014).

### 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).