While open to many different interpretations, “sustainability” generally implies the optimization of economic, environmental, and social factors when developing complex infrastructure systems. SAE 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**

SAE 515 meets on Mondays and Wednesdays from 12:30 - 1:50 in OHE 100D.

The last day to drop the class without a W grade is 7 September, and the last day to drop the class with a W grade is 9 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 SAE 515 grade is based on the following components:

- Short Papers (3) 15%
- Homework (3) 15%
- Term Project 70% (Paper 50%, Presentation 10%, Abstract, Prog. Report 10%)

There are no midterm or final exams. The SAE 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 to the class.

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

**Instructor Information**

Julie Albright  albright@usc.edu
Office Hours: TBD

Edward W. Maby  PHE 606  0-4706  maby@usc.edu
Office Hours: MW 10:00 - 11:00
Tentative SAE 515 Schedule - Fall 2018

Textbooks Cited

*Curbing Catastrophe: Natural Hazards and Risk Reduction in the Modern World*, Timothy Dixon (Required)
*Thinking in Systems*, Donella Meadows (Required)

Week 1 -

20 August

What is infrastructure? - What is sustainability? - What are systems? (Maby)

Matson: Chapters 1,2
*Sustainability: An Economist’s Perspective* - Solow

*Creating the Future We Want* - Hecht et al.
Response - Stutz
Rejoinder - Hecht et al.
*Is Sustainability Sustainable?* - Bonevac
The Limits to Growth and the limits to computer modeling - Hayes
Environmental Alarmism, Then and Now - Lomborg

22 August

The Tragedy of the Commons and Our Crumbling Infrastructure (Albright)

*The Tragedy of the Commons* - Hardin
*Tending the Infrastructure Commons: Ensuring the Vitality of Our Public Systems* - Little
*The Struggle to Govern the Commons* - Dietz

*Infrastructure: A Field Guide to the Industrial Landscape* - Hayes
Invaluable Resource, Highly Recommended!

Assignment: Personal introduction and sustainability perspective paper 1 - Due 5 September
Week 2 -

27 August

System Thinking (Maby)

Meadows: Introduction, Chapter 1

29 August

System Dynamics: Theory and Interpreting Stories (Maby)

Meadows: Chapters 2, 3
A Skeptic's Guide to Computer Models - Sterman

Assignment: None

Week 3 - No class on 3 September - Labor Day

5 September

System Dynamics: The Modeling Process (Maby)

Meadows: Chapters 3 - 6
Mistakes and Misunderstandings: Examining Dimensional Inconsistency - Gary
Problems with Causal-Loop Diagrams - Richardson

Reflections on the Foundations of System Dynamics - Richardson
Daisyworld: A Review - Wood

Assignment: System dynamics exercise 1 - Due 17 September
**Week 4 -**

**10 September**

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

*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 (Water, Land Use, and Nonrenewable Resources) (Maby)

*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 title - Due 24 September

**Week 5 -**

**17 September**

Infrastructures as Complex Systems (Albright)

*Matson: Chapters 3,4*  
*The Social Requirements of Technical Systems* - Whitworth  
*Guiding Principles for the Nation’s Critical Infrastructure* - ASCE

**19 September**

Actors in Complex Systems (Richard Little)

*The Role of Organizational Structure and Values in the Performance of Critical Infrastructure Systems* - Little  
*Dixon: Chapters 1 - 3*

Assignment: Complex infrastructure and resilient systems paper 2 - Due 1 October
Week 6 -

24 September

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
Dixon: Chapters 4 - 6

26 September

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

Dixon: Chapters 7 - 9

Reengineering Cities: A Framework for Adaptation to Global Change - Dawson
What to Do While the Water Rises - Little

Assignment: System dynamics exercise 2 - Due 8 October

Week 7 -

1 October

Social Pillar of Sustainability (Albright)

A Missing Pillar? Challenges in Theorizing and Practicing Social Sustainability - Böstrom
Environmental Justice - Mohai et al.

3 October

Model Development - Sustainia I (Growth Dynamics) (Maby)

Assessment of the Natural Environment: A Determinant of Natural Preferences - Weichart

Forecasting Electric Demand of Distribution System Planning in Rural and Sparsely Populated Regions - Willis

Assignment: Project abstract - Due 15 October
Week 8 -

8 October

Environmental Pillar of Sustainability (Tree People)

*Infrastructure and the Environment* - Doyle and Havlik
*Engaging Overburdened Communities in Permitting Actions: US Environmental Protection Agency’s “Promising Practices” to Promote Environmental Justice* - Forrest

10 October

Model Development - Sustainia II (Environmental Issues) (Maby)

Assignment: System dynamics exercise 3 - Due 22 October

Week 9 -

15 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

17 October

Conservation and the Gamification of Infrastructure Behavior (Albright)

*Gamification: The Intersection Between Behavior Analysis and Game Design Technologies* - Morford and Killingsworth

Assignment: Sustainability paper 3 - Due 29 October
Week 10 -

22 October

Water Case Study -
Reclamation System Successes and Failures: Toilet to Tap vs. Orange County (Albright)

*Domestic Wastewater Recycling: “Toilet-to-Toilet” and “Tap-to-Tap” Instead of “Toilet-to-Tap” - A New Approach - Antholz*

24 October

Data-Center Infrastructure (Guest Speaker, TBD)

*A New Methodology Toward Effectively Assessing Data Center Sustainability - Lykou et al.*

Assignment: None

Student projects and teams should be well underway. Changes to the scope of the team project must be submitted to the course instructors for approval no later than 5 November.

Week 11 -

29 October

Energy Case Study -
Gasland and Artists Against Fracking: Celebrity, Activism, and Non-Traditional Oil and Gas Extraction (Albright)

*Organizational and Celebrity Activism - Collins*

31 October

Energy Case Study -
The Smart Grid and Its Backlash (Albright)

*The Big Smart-Grid Challenges - Bullis*

*Preparing for Smart-Grid Technologies: A Behavioral Decision Research Approach to Understanding Consumer Expectations About Smart Meters - Krishnamurti et al.*

Assignment: Project progress report - Due 19 November
Week 12 -

5 November

Blockchain for Clean Energy (Killian Tobin, Omega Grid)

*Review of Blockchain Technology and Its Expectations: Case of the Energy Sector* - Chitchyan and Murkin

7 November

Linking Knowledge With Action and Unintended Consequences (Maby)

Matson: Chapters 5,6

Assignment: None

Week 13 -

12 November

Transportation Case Study -
Electric Vehicles and the Charging Infrastructure (Albright)

*Building Out The Electric Vehicle Charging Infrastructure* - Forbes Magazine

*Charging Infrastructure Planning for Promoting Battery Electric Vehicles: An Activity-Based Approach Using Multiday Travel Data* - Dong et al.

14 November

The Internet of Things and the Future of Infrastructure (Albright)

*The Bright Future of the Internet of Things* - Campolargo

*Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems* - Vermesan and Fries

*On Micro-Transactions in Urban Informatics* - McCullough

Assignment: None
Week 14 -

19 November

Class Presentations (if necessary)

Week 15 -

Class Presentations
Recommended Texts --- One of them may be helpful for your project!

**Sustainability**


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


Randall Curren and Ellen Metzger, *Living Well Now and In the Future* (MIT, 2017).


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


**Infrastructure (General)**


**Electric Power**


Peter Fox-Penner, *Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities* (Island Press, 2010).


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


**Water**


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


John Fleck, *Water is for Fighting Over and Other Myths About Water in the West* (Island Press, 2016).


Norris Hundley Jr. and Donald C. Jackson, *Heavy Ground: William Mulholland and the St. Francis Dam Disaster* (California, 2015).


Allison Lassiter, *Sustainable Water; Challenges and Solutions from California* (California, 2015).


**Waste Management**


*Transportation*


Edward Humes, *Door to Door: The Magnificent Maddening, Mysterious World of Transportation* (Harper, 2016).


Henry Petroski, *The Road Taken: The History and Future of America’s Infrastructure* (Bloomsbury, 2016).


**Telecommunications**


**Energy**


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


Alexis Madrigal, Powering the Dream: The History and Promise of Green Technology (Da Capo, 2011).


Robin M. Mills, Capturing Carbon: The New Weapon in the War Against Climate Change (Columbia, 2011).

Scott L. Montgomery, The Powers That Be: Global Energy for the Twenty-First Century and Beyond (Chicago, 2010).


Jim Motavalli, High Voltage: The Fast Track to Plug In the Auto Industry (Rodale, 2011).


**Mining**

David S. Abraham, *The Elements of Power: Gadgets, Guns, and the Struggle for a Sustainable Future in the Rare Metal Age* (Yale, 2015).


_Urban Systems_


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


Niles Eldredge and Sidney Horenstein, *New York City and Our Last Best Hope for a Sustainable Future* (California, 2014).


Tigran Haas ed., *Sustainable Urbanism and Beyond: Rethinking Cities for the Future* (Rizzoli 2012).


WorldWatch Institute, *Can a City be Sustainable?* (Island Press, 2016).

**Agriculture**


Gordon Conway, *One Billion Hungry: Can We Feed the World?* (Cornell, 2012).


Judith Schwartz, *Cows Save the Planet: And Other Improbable Ways of Restoring Soil to Heal the Earth* (Chelsea Green, 2013).


**Resilience**


David A. Cleveland, *Balancing on a Planet: The Future of Food and Agriculture* (California, 2014).


Donald Prothero, *Catastrophes! Earthquakes, Tsunamis, Tornados, and Other Earth-Shattering Disasters* (Johns Hopkins, 2011).


**Environment**


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

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


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


B. L. Turner II et al., *The Earth as Transformed by Human Action: Global and Regional Changes in the Biosphere over the Past 300 Years* (Cambridge, 1993).


Environmental History


**System Dynamics and Engineering Systems**


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


