SAE 515 - Sustainable Infrastructure Systems
Course Syllabus - Spring 2024

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 Tuesdays and Thursdays from 12:00 - 1:50 for “flipped” class discussion. Students should view a posted 45-minute lecture and read a related paper before each class time. The course also has a Friday discussion from 9:00 to 9:50 that covers modeling issues.

To get the most from this course, you should participate in class discussions.

The last day to drop the class without a W grade is 23 February, and the last day to drop the class with a W grade is 6 April. 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%
Exercises (3) 15%
Term Project 70%
(Paper 40%, Presentation 15%, Abstract 5%, Literature Report 5%, Progress Report 5%)

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 system 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

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Tentative SAE 515 Schedule - Spring 2024

Black - Lecture Topic
Red - Assignments
Textbook Cited:

Blue - Required Reading Prior to Class Discussion
Green - Recommended Supplementary Readings

Thinking in Systems, Donella Meadows (Required)

Week 1 -

Tuesday, 9 January

Sustainable Infrastructure Systems (Maby)

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
Transforming Our World: The 2030 Agenda for Sustainable Development
- United Nations
Infrastructure: A Field Guide to the Industrial Landscape - Hayes
Invaluable Resource, Highly Recommended!
Report Card for California’s Infrastructure: 2019 - ASCE

Thursday, 11 January

Systems Thinking (Maby)

Systems Thinking as a Paradigm Shift for Sustainability Transformation
- Voulvoulis et al.

Complexity, Problem Solving, Sustainability and Resilience - Tainter and Taylor
Resilience, Adaptability, and Transformability in Social-Ecological Systems
- Walker et al.
Infrastructure as a Complex Adaptive System - Oughton et al.
Infrastructure Ecology: An Evolving Paradigm for Sustainable Urban Development
- Pandit et al.
Integrated Infrastructure Systems—A Review - Saidi et al.

Friday, 12 January

System Dynamics: The Modeling Process (Maby)
Why Model? - Epstein

A Skeptic's Guide to Computer Models - Sterman
Boundary Matters: The Potential of System Dynamics to Support Sustainability
- Nabavi et al.
Reflections on the Foundations of System Dynamics - Richardson

Assignment: Personal introduction and sustainability perspective (Paper 1) - Due 19 January

Week 2 -

Tuesday, 16 January

Running the System: Core Actors (Richard Little)

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

The Social Requirements of Technical Systems - Whitworth

Thursday, 18 January

Engaging the System: Peripheral Actors and the Social License to Operate (Albright)


The Inner Dimension of Sustainability: Personal and Cultural Values - Horlings
The Politics of Sustainability and Development - Scoones
Sustainability and Regime Type: Do Democracies Perform Better in Promoting Sustainable Development than Autocracies? - Wurster
The Drivers of Greenwashing - Delmas and Burbano

Friday, 19 January

System Dynamics: Stocks, Flows, and Links (Maby)

Meadows: Chapters 1 and 2

Assignment: Notice of Team Memberships (not graded) - Due 2 February
Week 3 -

Tuesday, 23 January

The 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

Thursday, 25 January

Commodity Chains (Maby)

A Framework for Sustainable Materials Management - Fiksel

Aluminum, Commodity Chains, and the Environmental History of the Second World War - Evenden

Friday, 26 January

System Dynamics: Stories and Causal Diagrams (Maby)

Meadows: Chapters 3 and 4

Problems with Causal-Loop Diagrams - Richardson
Problems in Causal Loop Diagrams Revisited - Richardson

Daisyworld: A Review - Wood

Assignment: System Dynamics Exercise 1 - Due 2 February
Week 4 -

Tuesday, 30 January

Whose Resources? The Tragedy of the Commons and the Free-Rider Problem (Albright)

*The Tragedy of the Commons* - Hardin
*Extensions of 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
*Nothing to Fear but a Lack of Fear: Climate Change and the Fear Deficit* - Lowenstein and Schwartz

Thursday, 1 February

Stocks and Flows I - 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)

Friday, 2 February

System Dynamics: Archetypes and Intervention Strategies (Maby)

*Meadows: Chapters 5 and 6*

*Eight Archetypes of Sustainable Development Goal (SDG) Synergies and Trade-Offs* - Moallemi et al.
*Using Systems Thinking to Understand and Enlarge Mental Models: Helping the Transition to a Sustainable World* - Garrity

Assignment: Project Abstract - Due 9 February
Week 5 -

*Tuesday, 6 February*

What Resources? Energy Poverty (Albright)

*Energy and Social Issues* - Reddy

*Infrastructure and the Environment* - Doyle and Havlik

*Climate Change and Social Inequality* - Islam and Winkel

*Thursday, 8 February*

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

*Groundwater in Peril* - Jones

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

*Water and Energy Interactions* - McMahon and Price

*Water Scarcity: The Most Understated Global Security Risk* - Stuckenberg and Contento

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

*Friday, 9 February*

System Dynamics: Causal Diagram to Dynamic Model (Maby)

*Developing System Dynamics Models from Causal Loop Diagrams* - Binder et al.

*Causality and Diagrams for Systems Dynamics* - Schaffernicht

Assignment: Social Analysis of a Water or Energy Infrastructure System (Paper 2)

- Due 16 February
Week 6 -

Tuesday, 13 February

Who Has a Voice? Environmental Justice (Albright)

*Environmental Justice* - Mohai et al.

*A Case Study of Environmental Injustice: The Failure in Flint* - Campbell et al.
*Toolkit for Assessing Potential Allegations of Environmental Injustice* - EPA

Thursday, 15 February

Growing the Network: Human Demographics (Maby)

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

Friday, 16 February

System Dynamics: The Spatial Dimension (Maby)

*Modeling Structural Change in Spatial System Dynamics: A Daisyworld Example* - Neuwirth et al.

Assignment: System Dynamics Exercise 2 - Due 23 February
Week 7 -

Tuesday, 20 February

Growing the Network: Patterns of Development (Albright)

*Electric Vehicles and Psychology - Viola*

*The Dynamics of Brownfield Redevelopment - BenDor et al.*

Thursday, 22 February

Moving People and Freight (TBD)

*The Future of Transportation in Sustainable Energy Systems: Opportunities and Barriers in a Clean Energy Transition - Dominkovic et al.*

*A Review of System Dynamics Models Applied in Transportation - Shepherd*

Friday, 23 February

System Dynamics: Estimating Model Parameters (Maby)

*Mistakes and Misunderstandings: Examining Dimensional Inconsistency - Gary*

Assignment: Project Literature Report - Due 1 March

Week 8 -

Tuesday, 27 February


*Do Artifacts Have Politics? - Winner*

*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.*

Thursday, 29 February

Risk and Resilience (Richard Little)
A Methodological Approach to Political Risk - Little

Friday, 1 March

System Dynamics: Model Evaluation (Maby)

Assignment: System Dynamics Exercise 3 - Due 8 March

Week 9 -

Tuesday, 5 March

Left to Their Own Devices: The Digital Divide (Albright)

The Digital Divide: A Review and Future Research Agenda - Lykou et al.

Thursday, 7 March

Green Data: Digital Infrastructure and Sustainability (Bill Kleyman)

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

Friday, 8 March - No Class

Assignment: Risk Assessment (Paper 3) - Due 22 March

11 March - 15 March       SPRING BREAK

Week 10 -

Tuesday, 19 March

The Permitting Process: The Role of Media (Albright)

Organizational and Celebrity Activism - Collins

“No Fracking Way!” Documentary Film, Discursive Opportunity, and Local Opposition against Hydraulic Fracking in the United States, 2010 to 2013 - Vasi et al.

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

Thursday, 21 March

Getting Things Built (Wayne Kalayjian)

Sustainable Project Management Through Project Control in Infrastructure Projects
- Kivila et al.

Friday, 22 March

System Dynamics: Sustainia - The Environmental Model

Assignment: Project Status Report - Due 29 March

Week 11 -

Tuesday, 26 March

Smart Communities (TBD)

Smart Growth: A Prescription for Livable Cities - Geller

Thursday, 28 March

Sustainability Metrics (Maby)

Sustainability Indicators and Indices: An Overview - Jianguo Wu and Tong Wu

The Sustainability Metrics - Institution of Chemical Engineers

Friday, 29 March

System Dynamics: Sustainia - The Social Model

Week 12 -

Tuesday, 2 April

Social Media

Green Sustainability and New Social Media - Williams et al.
Thursday, 4 April

Distributing Risk: Microgrids and Microsystems
   *Possibilities, Challenges, and Future Opportunities of Microgrids: A Review* - Sharzad

Friday, 5 April

System Dynamics: Sustainia - The Economic Model

Week 13 -

Tuesday, 9 April

Gamification (Albright)

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

Thursday, 11 April

Documentaries and Film (TBA)


Friday, 12 April

System Dynamics: Sustainia - Resilience Assessment

Week 14 -

Tuesday, 16 April

The Smart Grid and the Internet of Things (Albright)

   *The Big Smart-Grid Challenges* - Bullis
   *The Bright Future of the Internet of Things* - Campolargo

Thursday, 18 April

Going Green and Getting It Right (Charles Cicchetti)

   *Engaging with the Politics of Sustainability Transitions* - Meadowcroft
Friday, 19 April

No Class

Week 15

Student Presentations