

# A SYSTEMS APPROACH TO GLOBAL ENGINEERING

CVEN 4157/CVEN 5157 (3 credit hours)

Spring 2023

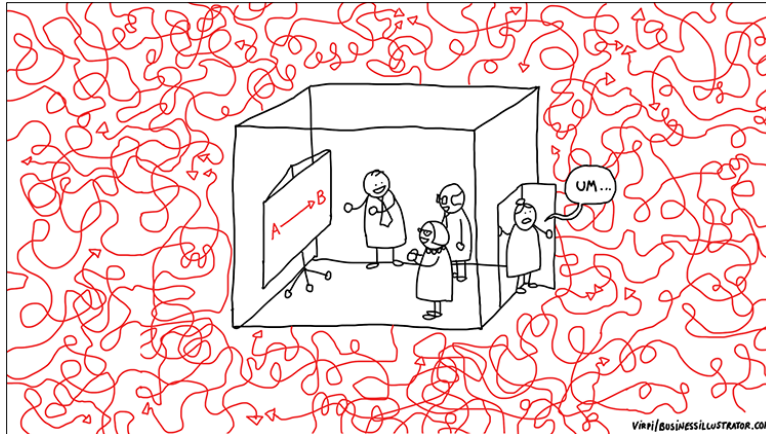


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## Instructor

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**Prerequisites** Senior or graduate level

## Course website:

[Week-by-Week Content for CVEN 4/5157 | Bernard Amadei | University of Colorado Boulder](#)

## Course Description

This course aims to introduce engineering students to the global context in which engineers are asked to operate in the 21<sup>st</sup> century. The course also introduces students to system dynamics tools and other decision-making tools (network analysis, agent-based modeling, etc.) to analyze the uncertainty and complexity inherent in global projects. At the end of this course, students should be able to:

- Have the ability to identify the multiple dimensions of engineering projects in a developed or developing country context;
- Be aware of the role non-technical issues may play in their technical decision-making;
- Appreciate the multi-cultural, social, and economic dimensions of practicing engineering;
- Understand the global interconnectedness of issues at different scales, from the local to the global, and why a systems approach can complement a more traditional linear approach;
- Formulate problems and their solutions in a more systemic and integrated way;
- Be able to approach a wide range of simple, complicated, and complex problems often characterized by different levels of uncertainty; and
- Be familiar with a range of decision-making tools.

These goals will be met through lectures, seminars, and projects. Students will be exposed to various projects in the developed and developing world. In each project, students will be shown how technical and non-technical issues have helped shape the project outcome.

Throughout this course, students will be presented with the importance of depth and breadth in their education and the need for a balance between specialization and a broader understanding of the linkages between engineering and society.

This course is offered as a senior and graduate-level technical elective.

### **Expected Learning Outcomes**

By the end of the course, students should have attained competency in the following areas:<sup>1</sup>

- participatory decision-making between many parties (ABET 3d)
- creation and administration of a community needs assessment (ABET 3c,e,h)
- creating and analyzing multiple design alternatives (ABET 3c,e)
- determining appropriate technology choices based on the existing knowledge within a partner community (ABET 3c,e,f,h)
- determining metrics for project design (ABET 3c)
- determining metrics for project success vs. failure (ABET 3c,e,h)
- understanding of general construction and safety practices within the partner community (ABET 3k)
- objective monitoring and evaluation of a built system (ABET 3b,e)
- creation of long-term communication strategies between in-country partners, partner communities, and project teams (ABET 3d)

**Class Hours:** Tu and Th from 8:00-9:15 am; ECCR 1B51 (some lectures will be on Zoom)

**Office Hours:** By appointment.

### **Course Readings:**

Students are responsible for all the required readings. These readings aim to (i) set the context for the class, (ii) generate questions for discussions, and (iii) deepen the student's knowledge of topics. A mandatory reading list will be provided for each class period. Textbooks used in class include:

- Amadei, B. (2019) *A systems approach to modeling the Water-Energy-Land-Food Nexus, Vol. II*, ISBN 9781947083547, Momentum Press (required).
- Laszlo, E. (2001). *The systems view of the world: A holistic vision for our time*. Hampton Press, Cresskill, NJ. (distributed in class)
- Meadows, D. (2008). *Thinking in systems*. Chelsea Green Publishing, White River Junction, VT. (optional)
- Richmond, B. (2004). *An introduction to systems thinking, STELLA software*. isee Systems, Inc., Lebanon, NH (web link mentioned in class).

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<sup>1</sup>These expected learning outcomes have been mapped to ABET Criteria 3 Student Outcomes: <http://www.abet.org/eac-criteria-2014-2015/>.

The web and the literature are rich in articles, videos, and websites covering the topics mentioned below. Students are expected to read three to four articles (or book chapters) before each class, work and learn with their peers, and present their findings in class.

### **Software:**

You are asked to purchase the student version of the *STELLA Architect* software (version 2.0.3) from <https://www.iseesystems.com/store/education.aspx>. Several student licenses are available. Select the one that fits your needs.

### **Course Content (30 lectures)**

Below is a list of topics that will be addressed during the semester. They are listed in no specific order.

1. Course Overview and Introduction. Introduction to Systems Thinking
2. A Systems View of the World
  - Looking at the world as a system of systems
  - Systems science and complexity science
  - System thinking and methods of decision making
3. Introduction to System Dynamics
  - Components of system dynamics
  - System dynamics qualitative and quantitative modeling
  - Stella Architect software
4. A Systems Approach to Human Development- Part 1
  - Concepts and models of development
  - Development challenges in the developed and developing world
  - A systems approach to the MDGs and SDGs
  - Scenario planning models at different scales
5. The Water-Energy-Land-Food Nexus
  - The Water of Ayole case study
  - Analyzing and modeling the components of a case study
6. A Systems Approach to Human Development- Part 2
  - Modeling population dynamics
  - System archetypes
7. Systems Approach to the Management of Development Projects
  - Stages of project management
  - Role of non-technical issues in all stages of project management
  - Right projects, done right, and for the right reasons. Who decides and participates?
  - Collecting and analyzing data for systems modeling
  - Defining issues and their dynamic hypotheses
  - Social network analysis and GIS
  - Methods of decision making and the importance of perspective (Zoom)
  - Capacity, vulnerability, and risk analysis
  - Developing an implementation plan
  - Failure and the engineering mindset
  - Deciding when faced with uncertainty and complexity
  - Biases and cross-cultural communication

8. Sustainability and Sustainable Development
  - Definitions
  - Integrating sustainability in engineering projects
9. Systems Approach to Community Resilience and Security
  - Importance of context and scale
  - Capacity and vulnerability
  - Critical infrastructure
  - Response to hazards, adverse events, and human migrations
10. Combining methods of analysis
  - Network analysis (UCINET software)
  - Agent-based and discrete modeling (AnyLogic software)
  - GIS (Esri ArcMap software)
  - Causal Analysis and Multi-Criteria Decision Analysis (MCDA)
11. Case studies

### **Assignments and Grades**

Student grades will be determined based on (i) in-class participation (20%), (ii) homework assignments and possible quizzes (40%), and (iii) multiple projects (40%).

### **Taking the Class at the Graduate Level**

Students interested in taking the course at the graduate level will be given additional reading assignments. They will be asked to work on more advanced projects and mentor undergraduate students.

### **Team Work**

All homework assignments and projects will be done in teams of undergraduate and graduate students.

## CLASSROOM BEHAVIOR

### Course Communication & Professionalism

In an effort to create a professional atmosphere within the classroom, it is requested that you:

- Arrive to class on time
- Follow required PPE and social distancing rules for COVID-19 (below)
- Turn off your cell phone
- Limit the use of your laptop computer to class purposes (very rare!)
- Put away tablets, newspapers, and magazines
- Refrain from having disruptive conversations during class
- Remain for the whole class, or if you must leave early, do so without disrupting others
- Display professional courtesy and respect in all interactions related to this class

Like any professional environment, you can anticipate some variation in expectations based on the culture of your workplace, the personalities of the meeting participants, and the size and subject of the meeting. We will set expectations for the large class meetings, but your project team will likely develop their style and expectations for your own meetings. Be sure that the whole group understands and is comfortable with the expectations for conduct. When in doubt, always err on the side of being professional!

Compliance with these expectations will assist us with the creation of a **learning community** and a high-quality educational experience. Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are critical concerning individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation, or political philosophy. For more information, see the [classroom behavior](#) policy, the [Student Code of Conduct](#), and the [Office of Institutional Equity and Compliance](#).

### Requirements for COVID-19

As a matter of public health and safety, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. CU Boulder currently requires COVID-19 vaccination and boosters for all faculty, staff, and students. Students, faculty, and staff must upload proof of vaccination and boosters or file for an exemption based on medical, ethical or moral grounds through the [MyCUHealth portal](#).

The CU Boulder campus is currently mask-optional. However, if public health conditions change and masks are again required in classrooms, students who fail to adhere to masking requirements will be asked to leave class. Students who do not leave class when asked or refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policy on [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the "Accommodation for Disabilities" statement on this syllabus (see below).

If you feel ill and think you might have COVID-19, if you have tested positive for COVID-19, or if you are unvaccinated or partially vaccinated and have been in close contact with someone who has COVID-19, you should stay home and follow the further guidance of the [Public Health Office](#) ([contacttracing@colorado.edu](mailto:contacttracing@colorado.edu)). If you are fully vaccinated and have been in close contact with someone who has COVID-19, you do not need to stay home; instead, you should self-monitor for symptoms and follow the further guidance of the [Public Health Office](#) ([contacttracing@colorado.edu](mailto:contacttracing@colorado.edu)).

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home. In this class, if you are sick or quarantined, please contact me at [amadei@colorado.edu](mailto:amadei@colorado.edu) or 303-929-8167. Because of FERPA student privacy laws, students are not required to state the nature of their illness when alerting me.

### **Accommodations for Disability**

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or [dsinfo@colorado.edu](mailto:dsinfo@colorado.edu) for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

### **Preferred Student Names and Pronouns**

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

### **Honor Code**

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code academic integrity policy. Violations of the Honor Code may include but are not limited to plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code ([honor@colorado.edu](mailto:honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the [Honor Code website](#).

### **Sexual Misconduct, Discrimination, Harassment, and/or Related Retaliation**

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. The university will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email [cureport@colorado.edu](mailto:cureport@colorado.edu).

Information about university policies, [reporting options](#), and support resources can be found on the [OIEC website](#).

Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents of sexual misconduct, dating, domestic violence, stalking, discrimination, harassment and/or related retaliation to ensure that individuals impacted receive information about their rights, support resources, and reporting options. To learn more about reporting and support options for a variety of concerns, visit [Don't Ignore It](#).

### **Religious Holidays**

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments, or required attendance. See the [campus policy regarding religious observances](#) for full details.

### **Activity-related Absences**

For varsity and club athletics, student organizations, and other activities that may require absences, please let me know early in the semester, and at least two weeks in advance, of travel or activities that will require you to be absent for class meetings, so that we may arrange makeups or alternate deadlines.

### **Spring Pause**

The week of March 27-31 will be used in this class as a spring pause to provide us all with a safe and supportive way to promote health, wellness, and learning without leaving campus. During this week, we will not have any exams or assignments due. We will still have classes with interactive class activities that will require your attendance and be part of your final course grade. While March 25 is a wellness day, attendance is still required for all other class sessions that week. I wish we could take a regular spring break, but public health concerns prevent us from doing so. I want to emphasize that it is still essential for you all to behave responsibly. Please do not use the week to travel or engage in risky behavior that could result in an outbreak on campus after we all return.