Problem Solving in Climate Change
AOSS 480

The Project

This course explores the intersections of the science of climate change with society: policy, business, economics, public health, energy, ecosystems, environmental engineering, information science, journalism, religion, *etc*. The approach is from the perspective that communities with heterogeneous interests are vested in both adapting to and mitigating climate change. The course will expose students to the fundamental factual and contextual elements surrounding climate change in order to facilitate effective participation in the response to realized and predicted climate change. The students will work in multi-disciplinary teams on projects to analyze current real-world problems and to develop strategies to address those problems.

This document is a description of the project.

Projects:

Background: The form of the projects follows from the experience of the professor, Richard B. Rood, when he worked in the federal government. Professor Rood was at NASA for more than 20 years. He successfully managed the development of complex, research-based, software systems to support NASA space missions. He also contributed to the development of multi-agency strategies to improve national capabilities in climate science.

At NASA, scientists and engineers are assigned to work on “complex problems with no known solutions.” This is an important concept for the problem solving in climate change. There are no “known” solutions, and, in fact, there is not a “single” solution. When one works on complex problems with no known solutions, one must be able to identify steps along paths towards solutions. One must also be able to develop strategies to go down these paths. That is - what ultimately needs to be done, what are smart things to do along the way, and how are those smart things done?

The statement that “it’s not rocket science” is often used in society. What is rocket science? Rocket science is, in fact, complex problem solving. At one level, rocket science uses well known classical physics in systems that are complex. It requires putting together myriad known things to do something new and specific. The specific goals to be accomplished help to define the order that is required to be extracted from the complexity. It’s critical to determine how things interact with each other.

Problem solving in climate change is much the same. To be clear, problem solving in climate change is not just a matter of "science." To address the challenges of climate change, we must address issues of energy use. Energy use is related to societal success; that is, robust economies, wealth and quality of life. Energy use and the management of the wastes of energy use influence the planet as a whole because there are a lot of people, and people want to consume energy. Therefore, the system in which the challenges of climate change resides includes economics, business, policy, energy, natural resources, health, agriculture, ethics; indeed, virtually all of society. In this system the climate and the science-derived knowledge of climate change sit in relation with many other issues; if given priority, it informs decisions on which strategies to use, which paths to follow.

Addressing a complex problem requires both reducing the problem to manageable pieces and keeping the unification of these pieces together as the ultimate goal. (Study E.O. Wilson's, *Consilience*.)

To approach problem solving in climate change it is necessary to move beyond the polarized positions that often follow from considering the push and pull, the advantages and disadvantages, the right and wrong of two-sided arguments; for example, carbon taxes versus a carbon market. This bimodal form of analysis is simplistic. It is necessary to bring the many constituencies that are vested in the problem together to converge to solutions. It is important to recognize that, when brought together, positions that are developed in the isolation of a single community are, logically, in conflict with the positions of other communities. This requires balance and optimization to achieve solution. This is thinking in terms of systems and big systems made up of small systems.

Foundation: The foundation of the form of the project is based on the following:

- Imagine that you are in a work environment. It could be in government, in resource management, in business, in academia; in fact, in many types of organizations.
- There is a need to develop a strategy to accomplish a specific goal; for example, develop an energy strategy for your hometown. (*other examples are listed below*).
    - The goal requires consideration of the interests of many constituencies. These can be characterized as
        - Government (policy)
        - Business
        - Non-governmental organizations
        - Knowledge generating community ("science")
- By virtue of a number of courses you have taken in school you are anointed as an expert.
- Several others in your organization are also anointed as expert by similar levels of credentials.

Your assignment:

Develop a knowledge-based decision package to advise the proverbial decision maker. Ideally, the decision package would include 2 or more viable options that weigh, more or less highly, the interests of the different constituencies.

Guidance:

1. It is important to separate what you know, what you think you know, what you want, and what you believe. It is critical to understand how what you want and what you believe impacts what you think you know.

2. A goal of the project is to recognize, explicitly, when you are being an advocate. (Good billion dollar projects have fallen because they were blinded by advocacy that alienated some of the constituent communities.)

    a. Being an advocate is a fine thing. You are a better advocate when you know and separate when you move from a knowledge-based analysis to advocacy.

3. A step that is virtually always the right "first" step is to take an inventory and identify all of the pieces that might be relevant to the problem being solved. Initially, don't form relationships between the pieces. Each piece might have several relationships.

    a. Relationships: Often we are predisposed to add structure to the pieces that we see. This structure might be hierarchical or it might be based on what we believe are cause and effect relationships. If possible, do not encumber the problem with this preconceived structure. It is possible that the relation between the pieces is more "biological" than hierarchical. This recognizes that the relationships might change as the solution path evolves.

4. Once the inventory is made, it is useful to identify the strength of the knowledge base associated with the different pieces. Is enough known to be factual? Is there enough information on which to base actions? Must action be taken even without enough information?

    a. A common occurrence is the conclusion to require "more research" so that more information can be obtained. Some times this is necessary and some times it is not. It can be a tactic to obstruct addressing the problem.

   b. This part of the problem also requires evaluation of the strengths of the team's expertise. Are the essential expertise bases covered? Is expert advice required?

5. Define one or more actionable steps – steps which are possible with the knowledge at hand and which are a step towards the larger goal.

6. Organize the pieces of the problem to support the execution of the actionable steps. Re-evaluate the knowledge in light of organization that has been made in support of problem solving. Are there gaps in the knowledge?

   a. The gaps will be classified into two categories. Those which must be filled, and those which cannot be filled, and therefore, contribute to the uncertainty in subsequent analysis and recommendation.

7. Once the pieces are organized identify those pieces which are internal to the solution and those pieces which are external to the solution.

   a. The externalities might be viewed as factors that force or define the solution space that are "beyond control." Or, perhaps, they are the "given."

8. Analyze how the pieces behave relative to each other. Is there a way to quantify this analysis? What is the sensitivity of the analysis to the assumptions of how the pieces behave relative to each other? Does the analysis reveal places where more knowledge is needed?

   a. A powerful tool is risk analysis, what are the dangers or losses that are potentially associated with an assumption or a decision.

9. Develop a recommendation of a path forward based on knowledge and the analysis of that knowledge. Identify where the knowledge is strong and weak. Identify relevant issues that are not addressed, adequately, and the consequences of not addressing them. Develop alternative recommendations based on different assumptions in the analysis.

Skills, techniques, and craft:

The skills, technique and craft to be developed are:

- How do you to define a tractable problem? How do you balance reduction of the problem to the unification of the problem?

- What is the essence of the problem versus the details? Which details are important? Do the important details change depending on the ultimate goal to be achieved?

- How do you check? What is the role of multiple paths to solution? What is the role of independent review?

- How do you separate what you know, from what you think you know, from what you want, and from what you believe? What is the value of separating advocacy from knowledge-based analysis?

- What are the strengths and weaknesses of "consensus?" What is the role of consensus in converging to recommendations? How do the recommendations balance the interests of the different communities? How do you determine optimal recommendations?

- How do you communicate across constituencies with different priorities, different vocabularies, and different values?

- How do you work in teams with those who have different priorities, different vocabularies, and different values?

Possible Projects:

Here are examples of possible projects. They are meant to represent projects that come from different types of organizations.

1. You work as a congressional staffer or an agency staffer. You are asked to analyze whether or not we should drill for oil on the North Slope of Alaska. You are required to consider climate change in the analysis. You are to make a team of experts from staff and provide a set of knowledge-based options for your congresswoman.

2. You are in a small company of 3-5 people, working as a startup providing climate expertise. A major paper company calls and wants to know how to think about its timber reserves in the presence of possible climate change policy. They want you to include an evaluation of the risks associated with designating trees as sequestration of atmospheric carbon dioxide.

3. You work for a credit card company which for every purchase the amount of carbon dioxide emitted into the atmosphere is calculated. Then they buy carbon credits to neutralize the emission. You are asked to quantify and validate that the program is good for the environment. What are the potential issues of perception; that is, the ethical implications?

4. You are in the Michigan state government, and Michigan is going to be the "energy state." Biofuels, wind energy, and hydroelectric are part of the proposal. Analyze the relationship of this energy policy to climate change policy and the impact it might have on Michigan's carbon dioxide emission inventory.

5. You work for a U.S. agency that funds research. There is an interdisciplinary program that is supposed to understand the relationship of climate change to societal impacts. Your task is to generate the most important research questions to answer in the next five years.