

Final “Products” of Your Complex Systems Project-Based Learning Exercise.
Notes to Students.

Hi Class! And now the fun really begins! It is often said, *“The best way to learn is to teach.”* Your team will this week become a teacher on important aspects of complex systems, as applied to infectious diseases such as Coronavirus and influenza. End result: On our last day of this five-week Complex Systems project, your team will submit a 700-word beautifully written essay and present a ten-minute “Lightning Talk” oral presentation on the key features of your essay. As your teacher has outlined to you, your essay should explain your selected topics of Complex Systems to a general newspaper audience (as well as to your family and friends!). Your work effort will be one of **synthesis** of important concepts and implications of the material you have studied, and presented in clear and yet precise language that most others can understand.

Organize and Select Topic(s). Today your team organizes and selects the topic or topics of complex systems you want to feature. Different teams are invited to focus on different items. Your teacher will help you organize. The remainder of the project, until the final day of presentations, will be your team working on organizing and presenting your ideas, your concepts for a general audience.

Data. To the extent that you can include local data in your work, great! With regard to Coronavirus data, many local newspapers have published daily state and local statistics. An example for us, near MIT in Cambridge, Massachusetts, is the *Boston Globe* – publishing daily updates to statistics of Coronavirus. (“Town-by-town COVID-19 data in Massachusetts” <https://www.bostonglobe.com/2020/04/15/nation/massachusetts-confirmed-coronavirus-cases-by-city/>). Utilizing such local statistics may make your arguments, your presentation, stronger.

Topics. Complex Systems has so many wonderful topics. And most are not well understood by the general public.

Feedback Loops. We have feedback, explained in loops – reinforcing loops and balancing loops. Colorful names: vicious cycles and virtuous cycles. And many loops have built-in delays. All result in complex interactions, yielding nonlinearity, like nonlinear convergence to Herd Immunity. Do most folks even know what Herd Immunity is? Well, you can explain, describe how we get there, and discuss whether that is even feasible for Coronavirus.

Beware of Unintended Negative Consequences! My favorite property of many complex systems is this: Often the apparently best immediate action may not be the best overall action, due to negative feedback loops with delay, which can create serious unintended negative consequences; remember that in the opening to the Complex Systems BLOSSOMS video on recycling? A recycling action viewed as “doing good” in the near term backfired as contaminated recyclables forced a closing down of international recycling plants – yielding no further recycling! While your efforts this week focus on infectious diseases, please feel free to utilize non-disease examples (such as recyclables) to prove the point you are trying to make. Can you think of an example of unintended negative consequences with regard to Coronavirus?

What about R_0 ? Can you explain in natural language the “equation” we have for R_0 ? How modifying your daily behavior can greatly reduce the chances of you becoming infected, which means reducing the chances of others becoming infected as well? If you surveyed people who can even describe R_0 . Most would express it deterministically. And R_0 of 2.0 means each nearly infected person infects precisely 2 others. But you know that R_0 is the mean of a random quantity, and that random quantity can include super spreaders who infect 20, 30 or 50 others. Can you explain that important phenomenon? And how we can still have $R_0 = 2$? Seems like a contradiction!

Other topics. There are many other topics to choose from:

- Stock and flow diagrams and how they can be applied to data (such as from Italy) to give us important insights. Maybe you can use such diagrams with your local Coronavirus data! Huge insights there!
- Role of vaccines, even when imperfect.
- Social distancing.
- Impeccable hygiene.
- Explaining a “Second Wave” of Coronavirus with feedback loops (now, that is a real challenge and quite important in terms of maintaining carefulness against infection.
- And much more.....

Research

Think of the entire 5-week exercise as a continuing set of opportunities to undertake research, on problems that fascinate you and for which you want to know more. Example: Expand your Italy Coronavirus work to another country, perhaps your own! Or perhaps your own state or community, if data are available. Example: Herd immunity — Can we ever get to it with Coronavirus? Or super spreaders, very important and poorly understood. And don't forget to devote some research time to your final essay and presentation.

700-word essay

Your audience is your family, friends and readers of a newspaper, either local or national. You and your team have learned so much over five weeks, and you can't wait to share with them the most important concepts, data and insights you have amassed. Be sure to include insights obtained by your own selected research efforts! Why do this? To educate your audience so that they modify their behavior when the next pandemic arrives, to maximize the chances of them not becoming infected. Writing style is clear, pithy and to the point. But feel free to be yourselves and develop your own style; if it fits, add some humor! Be careful, your essay may really be published!

Lightning Talk with slides presentation

You've got ten minutes with the aid of up to ten PowerPoint slides, to tell your story. This is a live presentation before your class, your teacher and invited guests. Subject matter: The key points of your 700-word essay plus your reflections on the entire 5-week exercise — for you and your team, what worked and what did not work, and why? Suggestions for next year, for the next class to do this. That's a lot to cover in ten minutes! Be sure to rehearse.

Effective use of visuals

Your PowerPoint slides should add another dimension to your presentation. They should not be bulleted talking points of your presentation. Worst kind of slide: 12 bulleted points, all text. Worst presentation: Standing there simply reading such a slide! Best kind of slide: Visually informative “eye candy” that compliments what you are presenting. Few words; mostly pictures, diagrams, small tables of information, catchy visually appealing stuff that creates that second dimension. To find such visuals, Google Image search is wonderful!

Team collaboration

To assure a successful five weeks, there is nothing more important than full cooperation and collaboration among all team members. Meet early in Week 1 to map out your “operating rules.” This could include how to resolve disputes, as with 100% certainty not everyone will agree first hand to everything over the five weeks. So, figure out how to converge to agreements. When the going gets tough, like when there is a lot to do, figure out ahead of time how you plan to apportion assignments, with each of you relying on everyone else in team to get to that desired SUCCESS destination. Your final essay and Lightening Talk will clearly demonstrate to all your successful working together as a team.

