Model Mysteries
An Exploration of Vampires, Zombies and Other Fantastic Scenarios to Make the World a Better Place

by Anne LaVigne and Lees Stuntz

You may have heard the phrase, “Lions and tigers and bears, oh my!” voiced by Dorothy in The Wizard of Oz many years ago. Her problems seem small in comparison to some we’re facing in today’s world. Many of our problems keep repeating themselves throughout history, finding their way into our popular culture, including fictional stories. So in this era, rather than lions, tigers, and bears, we might think about zombies, vampires, and other fantastical scenarios, OH MY! Even though these types of situations may seem a little silly, exploring them can help increase our understanding of some of the more real, difficult problems we’re working to solve. So, given that...

How can the distribution of a new mind-control technology be similar to working toward a goal, like improving your grades? How can vampires spreading throughout a big city be similar to the spread of a new deadly disease?

These and other explorations in the new book, Model Mysteries, are about deriving helpful answers, but the REAL point is to see how the underlying system works. As an example, if we were talking about automobiles, one set of lessons is to learn how to drive a car, but another — deeper — set of instructions is how to build and maintain an automobile. In the lessons, we look “underneath the hood” of each model.

Also, it’s important for us all to recognize that no model is ever going to be perfect, but model makers know that, and they continuously work to improve them so they behave more closely to how things work in the real world.

Getting Started

Overview

Never heard of stocks and flows? Never created models before? Don’t worry about a thing. As with most new adventures, the best way to begin is to do just that. This section introduces the basics and shows how to jump in and get started.

Who can use this book?

The modeling activities are intended for students from ages 10 to 110. In other words, if you’re interested in thinking about how to solve mysteries and like the idea of creating computer models and applying them to real-world problems, this book is for you. You can use it independently as a

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EDITORIAL

At the moment there is little sign of Fall in the air here in New England. We know it will come with the lovely crisp days and chilly nights, the orange, yellow, red, and russet canopies to walk under and their multicolored cushioning underfoot. We will enjoy the current warmer final days of summer while they last. What is here is the start of another school year with its challenges and joys. I hope everyone had a productive and enjoyable start to the school year.

For those of you who missed the ST/DM conference in June, the website has an excellent synopsis of that event.

The follow-up from the IACS (Innovation Academy Charter School) students after the 2016 DynamiQueST is an exciting example of the practical uses of the critical thinking created by ST/DM in schools. We are pleased to announce that the 2017 DynamiQueST will be held at WPI again next spring (March 17)!

In the curriculum department, the first four chapters of our new Model Mysteries book are now available on-line, as well as some short and, hopefully helpful, basic videos about the systems thinking tools.

Good luck with the start of the school year. As always, we love to hear from you about what you are doing.

Take care,

Lees
(stuntzln@clechange.org)

UPDATE

ST/DM Conference 2016

As you know, our 12th biennial ST/DM conference was held at the end of June this year. It was a successful and stimulating conference. We asked, “What did you find most valuable about this conference?”

Below are a couple of participants’ responses to the query:

- “Connecting with others in a variety of settings. Loved the variety of sessions and session lengths. It was really hard to choose, but that’s a good problem to have.”
- “Sharing strategies with other participants and hearing about their application of ST in their situations. The Climate Change Simulation.”

For an in-depth review of the conference highlights, including handouts from presentations, go to the conference page on the CLE website:

student, work with a group of students, or if you’re a teacher, share it with interested students to complete a guided or independent study project.

What is included?
The book contains six chapters, each with a new mystery to solve. Each chapter has a number of similar stories to try, depending on your interest.

Each chapter contains:

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What do you need to start?
First, you’ll need some way to create the models. STELLA® Professional software was used to create the models and graphics for this book, but you are free to try other options. Some options are free and some are not. Some options are online and some must be installed onto a computer or iPad. Check Appendix C for information about various modeling software options. Once you have a modeling program, you can dive into the mysteries!

As with most new endeavors, start at the beginning. The chapters are ordered from simpler to more complex so you can build your understanding as you move from one chapter to the next. If you get stuck, you can find hints about completing the chapter mysteries in Appendix B.

What are the basic building blocks?
To show how a system works, you need just four simple parts, plus one to see the results. By using these four parts, you can represent the interconnections in a system, creating something similar to a spider’s web. All the strands together show the big picture of a situation. If you pull on any one strand, it can affect many other parts.

Stock
A stock represents an amount or accumulation. It can be concrete, like the number of trees or animals in an ecosystem or abstract, like an amount of happiness.

Flow
Flows go into and out from stocks. The “stuff” of the stock can only get there through a flow. The flow is kind of like a river flowing into or out from a lake. Some rivers flow fast, while others move very slowly. Flows work in a similar way, showing how quickly “stuff” moves in or out of a stock.

Converter
A converter represents part of how the system works, but it isn’t a stock. For example, the number of people planting trees can be a converter.

Connector
Connectors show how elements affect one another. For example, the number of people planting trees affects the number of new seedlings in a forest.

Graph
Graphs show what happens to a model over time. Generally, you create a graph to show what’s happening to the stocks over time.

How are the instructions set up?
Each chapter contains a model you can build to help explore a mystery question. The included stock/flow diagram shows the basic structure of the model. Simply recreate the model in the modeling software of your choice.

1. Each part has a unique label.
2. Each part has a number or symbol inside. They show what you need to do to make the math work. When you actually create the model, these numbers will not appear on the diagram as they are shown in the book.

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Professor Chung’s ‘Reading Hamlet Together’ program: a participatory class from Hamlet’s standpoint

Analyze feelings with rating of ‘revenge’

Research professor Chang Kwon Chung at Interdisciplinary Program of EcoCreative, the Graduate School, Ewha Womans’ University, pioneered a Shakespeare’s Hamlet Modeling program. An educational program for reading Hamlet was introduced for the 400th anniversary of William Shakespeare’s death.

Participants evaluate Hamlet’s feelings from the perspective of ‘I am Hamlet’, analyzing the story which dramatized Hamlet’s revenge against the uncle who poisoned his own father. Then, they must rate each scene from Act I to Act V in order to later create a ‘revenge index of Hamlet.’

For example, the readers analyze Act III, when Hamlet arranged the play representing his uncle’s murder right in front of the uncle. Then, they assign a rating between 0 and 10 to Hamlet’s feeling of vengeance, comparing their ratings with others’ ratings. A rating of 0 means that Hamlet would presume that there is no evidence that the uncle is guilty, whereas a rating of 10 means the opposite.

Professor Chang Kwon Chung is not an expert in English literature. He studied German Education at Seoul National University, but later received his PhD in Business Management at the Seoul School of Integrated Sciences and Technologies, or aSSIST. Dr. Chung, who usually explores new methodology for humanities, has arranged special lectures about Hamlet since last May at high schools such as Daeil Foreign High School. He recently gave a lecture on Hamlet with 28 students in Samgaksan High School’s freshman class. Only eight of the students had heard about Hamlet, and only one student had read the whole play.

Professor Chung distributed a short-lined abstract of the Hamlet script translated into Korean to students and spent 2 hours letting them analyze the text. He, meanwhile, recited something important several times.

“To be, or not to be - that is the question …
But that the dread of something after death -
The undiscovered country from whose bourn
No traveler returns - puzzles the will …
Thus conscience does make cowards of us all.”

Professor Chung said, “Hamlet repeatedly delayed his revenge. He kept thinking too much. It is folly to be wise.”

Students were arranged in groups of four and each assigned and submitted a rating. Professor Chung then used a computer simulation to quantify the play with those scores. There was a significant difference between the students’ final scores. The students especially disagreed on a particular scene when Hamlet’s uncle tries to exile Hamlet. The students who assigned a high score of 8 to the probability of revenge said, “before his exile, Hamlet could be planning to take his revenge.” In contrast, the students who assigned a rating of 5 were more cautious and maintained that “Hamlet might have a strong feeling of vengeance, but could think opportunity to act was not enough.”

The students who participated in the program commented, “We thought Hamlet is difficult, but now we want to read the book, thanks to this lecture.”

Professor Chung said, “My plan is to spread this special lecture about Hamlet not only to schools, but also to libraries.”
A group of high school students at Innovation Academy Charter School (IACS), a public school in Tyngsborough, MA, set out to investigate the crisis of opioid addiction spreading in the United States. They organized a study group during a choice block that met once a week during school year 2015-16, and plan to continue their work. Here’s how they tell their story in their own words and diagrams:

Emma and Jaimie presented at DynamiQueST 2016 at Worcester Polytechnic Institute in Worcester, MA:

We are a part of an elective class at our school called Drugs in Society where we explore drugs from when the War on Drugs began, the chemistry and psychology behind drugs, the stigma against addicts, the ever-changing government laws and policies surrounding the issue, and the impact of drugs on our local communities.

We created this project [presentation at DynamiQueST 2016] to help others navigate through this complicated topic with the use of Systems Thinking tools. We also have decided to incorporate how this issue has gained attention in the public eye.

The group of students and adults adopted the name IACS DEALS (Drug Education and Awareness Leaders). In May 2016, they presented an evening program at the school called Communities in Crisis: The Faces of Addiction - Awareness and Response. The program was designed for parents, teachers, and high school students.

Attendees toured information stations and resource tables, watched a film, listened to presentations and a panel discussion, and enjoyed student musical performances. Kiersten told how she came to be involved and described the evening presentation:

Although many people are unaware of this, there is currently what is being called an opioid epidemic throughout the US, but especially within Massachusetts. Many more people are using opioids such as heroin and overdosing than ever before. Like many of those people, I was very unaware of this issue until it was being talked about in my forensic science class this year. After hearing about this problem, I decided that it was something that I wanted to dedicate some of my time to. Later on, I became involved in a club at my school called IACS DEALS (Drug Education and Awareness Leaders) that talked about these issues and worked to further educate people on these issues.

As a group, we organized an event that we would hold at the school to help make people aware of this issue that was becoming more and more prominent within our community. In the “Communities in Crisis: Awareness and Response” event, a movie was viewed that explained the current epidemic and was followed by a panel, including police, hospital workers, volunteers, parents, and people struggling with addiction, who further discussed the issue. These personal stories added to the powerful message being conveyed through this event and left everyone feeling impacted and more aware of how large of an epidemic it is. We created posters and other displays that portrayed addiction and facts about the crisis. The final major component to this event was the “Hidden in Plain Sight” room that showed the room of an addict and helped parents to further identify the signs of addiction.

This was a large scale event that required an immense amount of planning, but there are many other ways everyone within the community can get involved and help to end this epidemic. Opportunities exist for volunteering at organizations involved or spreading awareness via posters, flyers, speeches or even simple conversations. Everyone within the community has a role in solving this epidemic and making the community better no matter how small the contribution may be.

Libby described her impressions at the group’s evening presentation, “Communities in Crisis,” for the school and community.

My mom has always taught me that everyone is fighting a battle you know nothing about. I have never seen a better example than what happened the night of our school’s drug awareness presentation called, “Communities in Crisis: Awareness and Response.” I am going to call the young woman from this story Jane for her privacy. Jane and her mother arrived at the event right on time. From first impressions, the duo seemed confident in themselves, as if they could take over the world. I soon learned that this wasn’t always the case.

About an hour later, presentations began in the auditorium. Jane’s mother was the second to speak. I would come to find out that Jane was a former student at the school I am currently attending. Two weeks before her graduation, she broke down to her mother saying that she needed help for an opioid addiction. Upon hearing this, I realized something I never have before. The beautiful young lady, who seemed as though nothing could stop her, was now crying in her seat recalling her battle with drug addiction. I realized that no matter how hard she tried, she will never be able to get back the terrible years that she struggled with addiction. Her mother continued to speak about her year of struggle getting her daughter in and out of rehab, and doing as much as she could so she could get her baby back.

This is why I am in IACS DEALS. I hope through the work my peers and I are doing, I will be able to get someone’s son or daughter back home, sober and healthier than they have ever been. At fifteen, I am not able to do a lot yet to help addicts, but hopefully through awareness, I will be able to help inspire someone who will. To close her presentation, Jane’s mother announced that her daughter was three years clean from drugs. Hopefully through our work, we will be able to help other people to say that about themselves, or others in their lives that are affected.

From Emma’s speech at the Community Awareness event:

Why?

Addiction impacts everyone and I want people to understand it. I want people to understand that compassion can really heal and that those who suffer from addiction are not bad people. Addiction is no longer “not
Students Examine the Opioid Crisis

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our problem;” it is everyone’s problem. Everyone knows somebody who suffers from addiction. My ultimate goal is to educate students on drugs and addiction from many different perspectives so students leave with a stronger understanding of all the sides of addiction. Most importantly, I want students to leave with a better understanding to help and support somebody they love who is suffering.

What we do
We explore the history, current policies, chemistry, psychology and stigmas of addiction and how it impacts our world on a local and global level. We work through these issues using many different strategies, a large one being systems dynamics, often found in the workplace. We raise awareness in our school community through encouraging class discussion and events throughout the year.

From Emma and Jaimie’s DQ presentation:
Throughout this project, we learned much more than an article could have told us. We tried to view the situation from different perspectives as we made our diagrams, which caused our mental models to change. Through our causal loop diagram, we saw some ways you can end the reinforcing loops, causing the opioid epidemic to possibly come to an end. This gave us a new view of the complexity of drugs, and how difficult it is to end the epidemic. After determining points where we can end the opioid epidemic, the questions we are left with are how can we use this to help addicts recover and prevent new addicts from forming?

[Emma and Jaimie’s causal loop diagram is at the top of the next page.]

Why systems thinking?
Students at IACS use systems thinking in their classes and advisory teams so they were able to apply those tools to their study of the addiction crisis. While gathering data, students found behavior-over-time graphs painting a grim pictures:

As Emma and Jaimie said, causal loop diagrams helped them find feedback that was exacerbating the problem and to search for ways to move from reinforcing to balancing loops. In the reinforcing loop at the top of the diagram, they identified stopping overprescription as the leverage point to slowing down the feedback. In the bottom part of the diagram, preventing relapse would be critical in stopping that reinforcing loop.
Students identified several generic structures, characteristics in the addiction crisis that can be common in complex systems:

Unintended consequences and fixes that fail –
- Declaring a “war on drugs” increased the traffic of drugs into the US
- Well meaning medical professionals contributed to patients’ dependence on opioids

Structure generates behavior – a delivery system for smuggling has long been established

Mental models affect perception, and changing perspectives can increase understanding –
- Historically addicts have been considered criminals rather than victims
- Addiction is a problem across society, not confined to specific demographic groups

Progress began to be made during the school year. Public awareness grew, communities began to expand programs for people in crisis, and legislatures passed progressive measures designed to reverse the growing problem. IACS students will continue to be part of the solution.

Students contributing to this article:
Kiersten Callery
Emma Chaitin
Libby DiGesse
Jaimie Thibeault
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3. The symbols show math operations (+, −, *, or ÷) or a squiggle sign, meaning that you need to create a special graph.

Then you’ll create a graph with the stock (variable) on the y-axis and time on the x-axis. That way, you’ll see what happens over time. You’ll check the results to make sure that you get the correct results, and if not, adjust the model. NOTE: If you choose software other than STELLA®, you may see slightly different results on the graph, but the value at the end should still match.

After that, you can explore other situations using the same basic model.

So, are you ready to go? Let’s get started with the first mystery – how to stop the zombie chickens from over-populating Earth!

Chapter 1: Growing, Growing, Gone

Dive in – How can you stop zombie chickens from over-populating planet Earth?

Sometimes it's fun to imagine a crazy, “What if?” Like, what would happen if one day a zombie chicken were to appear? Where that zombie chicken is from, no one knows, but now that it’s here, it's trying to populate planet Earth with more and more zombie chickens. It starts with just one zombie chicken, but that chicken grows bigger and bigger until one day, POP; now two zombie chickens look dazed and ready to grow. The process repeats, and POP, now four zombie chickens look dazed and ready to grow.

How fast will the zombie chickens grow and pop? How can you stop it from happening?

Put Together the Pieces

First, you need some “Zombie chickens” (ZCs) and a way for them to increase (replicate) and decrease (get cured). Create the following:
Input the numbers as indicated in the diagram. See Appendix B: Equation Helper for assistance if needed.

Set up the model’s “Run Specs” as follows:

- Start Time = 0
- Stop Time = 12
- DT = 0.25 or 1/4
- Time Units = Months
- Integration Method = Euler

Also make sure that the stock is set to allow negative values. In other words, if you are using STELLA® software, you must un-check the “Non-negative” box for each stock you create.

Create a graph of ZCs. Run the model to see what happens. If all the initial values are correctly entered, you should see the following graph line and ending numerical value. You may need to set the graph’s scale to match the one below.

If the behavior is different, recheck your connections and equations. If the behavior is still not matched, check the Appendix B Equation Helper for guidance.

Experiment, changing the numbers for ZCs, replicating ZCs and curing ZCs to see how it affects the number of ZCs over time. Change only one number for each run. You should see variations similar to the graph lines shown in the second graph.

Notice that no matter what numbers you input, the ZCs grow, decline, or stay the same in a straight line. That doesn’t quite match the situation of one becoming two, two becoming four and so on. Another issue is that the model allows for a negative number of ZCs, which, of course, is not possible. This means that the model structure is wrong; it needs to be adjusted to prevent this impossibility.

Add a little more to your model and adjust the equations. The arrows coming out from the stock of ZCs to the flows show that the number of ZCs affect how many go in or come out. Note: The * symbol means to multiply the variables that affect that part.
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Run the model to see what happens. If all the initial values are correctly entered, you should see this graph line and ending numerical value. Notice that the line is now curved, so the ZCs are increasing faster over time. If the behavior is different, recheck your connections and equations. Note that although the model has a way to cure ZCs, the number is currently set to 0, so no ZCs are cured.

Dare to Dig Deeper

Dare yourself to find solutions using the model you created. Some key questions to dig into are:

1. How long would it take before the number of ZCs outnumber the number of people on Earth?
2. Is it possible to stop the invasion? What would be necessary to reverse the trend? How might a cure help solve the problem?

Dare

Keeping the numbers the same as shown in the initial diagram, how many months will it take for the ZCs to outnumber the number of people on Earth? To keep the model simple, let’s assume that the human population stays the same. At the writing of this book, the population was approximately 7.4 billion people. Hint: You’ll need to change the number of months the model runs.

Sketch the graph and then compare it to the graph in Appendix B: Equation Helper.

Double Dare

1. Think about what is needed to prevent the ZCs from taking over the Earth. Up to this point, the cure rate is set at 0. This means that no ZCs are changed back into regular chickens. What do you predict will happen if the “Cure rate” is set to 25% cured per month? The setting would be 0.25.

2. Try different numbers for the “Cure rate” to determine what is needed to prevent the zombie takeover.
Triple Dog Dare

In reality, it would take time to develop a cure. Given that, will it still be possible to stop the ZCs in time to save the Earth?

Change the equation for “Cure rate” to show the time it takes to develop the cure.

The equation for “Cure rate” is: STEP(0.5,10). This means that it takes 10 months to develop a cure. No ZCs will be cured from months 0-9. Starting in month 10, you’ll cure 50% of the ZCs per month.

What do you predict will happen to the number of ZCs over time?

Try some different ideas, changing only one number at a time. Sketch your best graph, showing how to eliminate the ZCs.

Dare to Reflect

Think about the changes that were most effective and also realistic in solving the ZC problem. For example, if you develop a cure, consider whether you gave a reasonable amount of time for the cure to be created and put into place.

Connect to Other Stories

Many other situations (real and fictional) behave in a similar way as this simple model does. Modify the labels and numbers for the zombie chicken model to explore one or more of these stories. Each has the same three levels of challenges. You can even make up your own stories that have behaviors similar to those seen in this model.

Story 1: Dodo Disappearance

Overview

In the 1600s, the dodo, a type of bird, became extinct. Use this model to consider the basics of why this animal went extinct and how that extinction might have been stopped.

Details

1. Time units__________
2. Dodos (stock)__________
3. Birth fraction__________
4. Death fraction__________

D Dare

1. Re-label and change the numbers for the previous model to make sense for this situation.
2. Determine how long it would take for the population of dodos to disappear.

Double Dare

Using the model, think of at least two ways to slow down the decline of the dodos.

1. Choose one idea and change the number for that part in the model to

Thoughts and Insights from this Model:
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achieve slower decline. Make sure that your number is realistic.

2. Try some different ideas, changing only one number at a time. Sketch your best graph.

D Triple Dog Dare

1. Can you add something to the model to show a new plan to save the dodos? Perhaps a new law limits how many are hunted, or maybe a breeding program is implemented.

2. What could you do to increase the number of dodos rather than having them go extinct?

Story 2: National Debt

Overview

The United States (and some other countries) have borrowed money to pay for government programs. This borrowed money is called the National Debt. Every year the debt goes up based on the deficit (the new money borrowed each year) and the interest being charged on the existing debt. Each year, payments are made, but it hasn’t been enough to reduce the actual debt. You can see the current debt here: http://www.treasurydirect.gov/NP/debt/current. As of June 2016, the debt is more than $19 trillion.

Do some research to determine logical values for the model's details.

Details

1. Time units_____
2. National debt (stock)_____
3. Amount added (deficit) per time unit_____
4. Amount paid per time unit_____
5. Interest rate_____

D Dare

1. Re-label and change the numbers for the previous model to make sense for this situation.

2. Given the current pattern, how much will the debt be in 2050?

D Double Dare

1. Using the model, think of at least two ways to slow the accumulation of debt.

2. Choose one idea and change the number for that part in the model to achieve slower growth. Make sure that your number is realistic, that is, consider that if you cut spending, you are actually cutting government programs, such as military personnel, aid to low income families, and subsidized farming.

3. Try some different ideas, changing only one number at a time. Sketch your best graph.

D Triple Dog Dare

1. Can you add something to the model to show a new plan to decrease the debt? Make sure that your additions are realistic.

Story 3: Interested in Interest

Overview

You want to save money for college. Consider how much you will need each year for tuition and living expenses. Adjust the time frame to run for the amount of time you have to save between now and when you graduate from high school.
Details
1. Time units__________
2. Money (stock)__________
3. Deposits per time unit__________
4. Interest rate earned__________

**D Dare**
1. Re-label and change the numbers for the previous model to make sense for saving for college.
2. Given your current saving rate, how much will you have by the time you graduate from high school?

**D Double Dare**
1. Reconsider your saving rate in order to determine a plan to save the total amount needed. Using the model, think of at least two ways to increase the amount saved.
2. Choose one idea and change the number for that part in the model to achieve faster growth. Make sure that your number is possible, that is, you can realistically save that amount of money in the time between now and your high school graduation.
3. Try some different ideas, changing only one number at a time. Sketch your best graph.

**D Triple Dog Dare**
1. Can you add something to the model to show a new plan to increase your savings? Make sure that your additions are realistic.

**Story 4: Make up your Own**
Create your own story with details, using an issue that behaves in a similar way. Modify the model to match your story, and use it to solve the problem(s).

**D Dare to Reflect**
One story I tried was______________________________
How did you adjust the model to solve the problem(s)?
Create labels for the diagram and add any new part(s).

What would these model adjustments actually mean is happening in the real world?

**Thoughts and Insights from this Model:**

Please visit the CLE website for the other model mysteries and the appendices in this book.
New Video Resources

What is a behavior-over-time graph? Why are causal loops useful? How do you start a connection circle? What is a stock/flow diagram? These questions and more are answered in four short introductory videos describing systems thinking tools and their potential uses. Find these, as well as other videos, on the Creative Learning Exchange YouTube channel: https://www.youtube.com/user/CLExchange.

WPI to host another DynamiQueST!

With Oleg Pavlov’s help at WPI, we have a date and place for the 2017 DynamiQueST. We were able to secure three rooms together in the WPI Student Center, Odeum A,B and C, on Friday, March 17, 2017. We are returning to the functional and pleasant location where DQ was housed at WPI for 2001-2008. It’s time to start thinking about how to encourage students to submit projects and join in the fun in March.

Interested In Investing?

If you would like to invest in our effort here at The Creative Learning Exchange, your contribution would be appreciated. You may donate any amount you wish; perhaps $50.00 is a reasonable amount for a year. All contributions are tax-deductible.

Enclosed is ___________________ to The Creative Learning Exchange to help invest in the future of K-12 systems education.

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