Getting Started:

Five lesson plans to help teachers introduce System Dynamics to their students

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Introduction

After reading through Road Maps 1 to 4, I realized that everything I had read made me extremely eager to start using System Dynamics with my students. However, I quickly found that going from Road Maps to the classroom was not going to be an easy task. Most often, new curriculum ideas are supported by four or five initial lesson plans to help get the teacher started. I proposed to create these start-up lesson plans and here they are!

The following five lesson plans, complete with class assignments and homework assignments, will take teachers and students through the necessary steps in any new learning method. The plans begin with an extremely simple lesson on systems in general. Students will begin thinking about systems they know and the factors that affect systems. From this general start, the lesson plans begin to encourage students and teachers to make diagrams or models of systems that they use or see everyday.

Once the students have the confidence that comes from familiarity, they will start using the language and shapes of System Dynamics. Learning the definitions for "stock" and "flow" and learning to associate those terms with shapes from Stella are the next necessary steps. After the students have a few definitions and have experimented with drawing simple models, they will learn to assign numerical values to stocks and flows. When the students are comfortable and confident with the more simple beginning concepts, the concept of feedback is introduced.

Recognizing feedback takes practice through analyzing different systems and determining how to best model those systems. Exercises and practice are necessary until the teacher feels that the students are comfortable trying to model more complex systems. Finally, the teacher will introduce the STELLA software and demonstrate to the students how they can model using the computer and actually watch a system working.

The lesson plans that I have created will take a teacher and his or her students through all of these steps and bring them to a level of confidence at which they are eager to begin looking at more subject-specific modeling.

Please note that these lesson plans assume the teacher is already familiar with the concepts introduced in Road Maps. These lessons are intended to complement Road Maps.

Lesson Plan One

Materials Needed:

A blackboard
Chalk
Copies of the accompanying assignment sheet (2 per student)

Anticipatory Set: At the beginning of class, put the title "System" on the board.

Objectives: By the end of the class, the students will have:

1. accumulated a written list of different systems operating in the world.

2. spent time thinking about the different parts of simple systems that work together.

3. gained some experience working cooperatively with their classmates.

4. gained an understanding that they will spend the next 5 or 6 classes learning about systems with the goal to apply what they have learned about systems to the subject of that particular class.

Method:

1. With the title "Systems" on the board, ask the students to give examples of systems they know. Write all responses on the board under the title. Ask the students why they think their suggestions are examples of systems.

2. After a sufficient list (perhaps 20 items) has been written down, add a few items of your own that students would not generally think of as systems (i.e.., a bank account, a cup of coffee cooling, water in a bathtub, etc.)

3. Building on their confusion or surprise that you think a simple thing like a bank account is an example of a system, explain to the students why you have started the class as you have.

    a) Explain that almost everything that changes or works is actually a system.

    b) Explain that too often in school or in life we learn about one part of something and move on. We need to learn to look at all parts of a system and how they work together to really understand something. Even relatively simple systems can produce complex behaviors.

    c) Discuss examples of instances in life where being able to understand all parts of something changes attitudes, actions, and opinions (e.g., the environment, conflict, paying taxes).

d) Explain to the class that in the next five or six classes, you will be attempting to teach them to look at all parts of systems and how the parts work together so that you can start applying this type of learning to your subject.

4. Choose an easy, concrete example from the list on the board. Together with the class, list all of the related factors that make the system work (using the format of the assignment provided (page 6)). The students should be a little amazed at how many factors are involved that they would not normally consider.

5. Divide your class into groups of four.

6. Pick four or five examples of simple systems from the board and assign one to each group. The best examples to start with are concrete ones to which the students can easily relate and that are also easy to draw (e.g., bank account, bath tub, etc.).

Assignment:

Give each student in the class an assignment sheet. Explain to the class that the assignment is to choose one of the systems not already done and write the name of the central element of the system (e.g., "bank account") in the largest circle on the assignment sheet (just as you did together on the board). Have the groups fill in the remaining smaller circles (as many as possible) with any elements they can think of that are involved in that system.

Explain that each member of the group should have an accurate and complete diagram because you will decide at the end of class whose diagram you will be collecting to be marked as the group's mark.

Have each group pick a spokesperson who will explain the group's results.

Give the students a set amount of time that they will have to discuss and work on filling out the assignment sheet.

Check for Understanding:

When the set time has expired or the students seem to be done, have the students return to their seats. Have each group's spokesperson explain her or his group's results to you and the rest of the class.

Closing

Recap what you did this class. Ask the students why you did this assignment today. Explain to the class where you plan to head for the next five classes.

Independent Learning

For homework, give each student another assignment sheet. Have each of the students take one of the examples of systems on the board (that was not presented in class) and repeat the assignment using the chosen system.

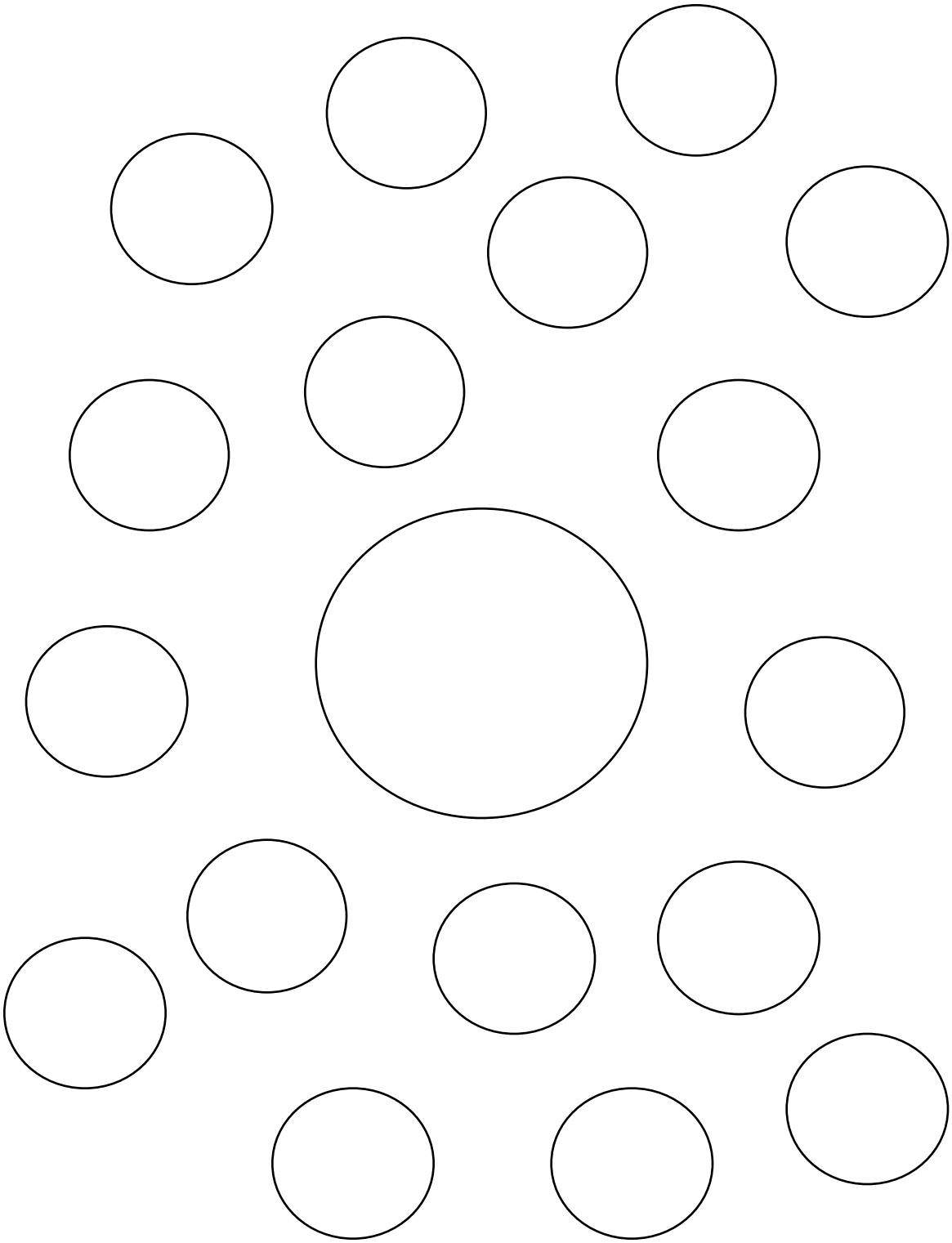
The instructions for the assignment sheet are as follows:

1. Choose the main element of the system and write its name in the largest circle.

2. Think of every possible factor that affects the central element and write the names of those factors in the smaller circles.

Lesson Plan One

Assignment and Homework Sheet



Lesson Plan Two

Materials needed: Chalk
A blackboard
An overhead projector
Overhead pen/marker
Acetate copy of Bathtub Example (make one)
Copies of Bathtub Example for students (page 10)
Copies of assignment sheet for students (page 11)

Anticipatory Set: Set up the blackboard so there is room for four students to go to the board and draw their examples of parts of systems prepared as homework for Lesson Plan One.

Objectives: By the end of this class, the students will have:

1. spent time analyzing the parts of systems that their peers had analyzed out of class time.

2. been exposed to examples of the parts of systems that their peers have examined.

3. been told that the work they did last class and the work they will be doing for the next set of classes will be referred to as "System Dynamics."

4. written definitions of the terms “Stock” and “Flow” in their notebooks.

5. labelled a diagram of a bathtub with terms used in System Dynamics.

6. spent time determining whether examples on their assignment sheets are stocks or flows.

Instructions:

1. At the beginning of the class, pick four students to put their examples of the assigned homework (from Lesson Plan One) on the board.

2. Ask the rest of the class to be thinking of any parts of the systems being drawn on the board that might be missing or should be considered.

3. As a class, examine each of the parts of the systems on the board. Ask the class if they notice any similarities among the systems. Discuss their comments and observations.

4. Explain to the students that before studying any new topic, it is essential to be informed of the language or terms used. Explain to the students that the term "System Dynamics" refers to the work they did last class on systems and the work that they will continue to do in understanding how systems

behave. Write “System Dynamics” on the board. It might be necessary to explain to the class the meaning of the word “dynamics.”

5. Explain to the students that they are also going to learn two new terms today -- Stock and Flow. Write those two words on the board.

Method:

1. Hand out the copies of "The Bathtub Example" to each student. Place your acetate of "The Bathtub Example" on the overhead projector so that the whole class can see it.

2. Explain to the class that using a bathtub to help explain the terms Stock and Flow will help them later when they will be asked to determine the stocks and flows of more complex systems.

3. Ask the class what they think the term stock means. Write a good definition at the bottom of the drawing of the bathtub. Have the class do the same. Ask the class what they think a flow is. Write a good definition of flow at the bottom of the drawing of the bathtub. Have the class do the same. Stress the importance of understanding the differences between the two. (Examples of definitions for the two terms can be found at the end of this lesson plan.)

4. Ask the class where they would label the stock and flow of the bathtub. Label the overhead drawing of the bathtub putting the word “stock” in front of the arrow pointing at the water in the tub. Write the word "flow" in front of the arrow pointing at the taps from which the water is flowing. Tell the students to label their drawings also.

5. Ask the students (unless a student has already noted this) if there is another flow to consider. Label the drain area at the bottom of the tub as a flow also. To clarify the two flows, you can label the water coming from the tap, “InFlow,” and the drain area at the bottom of the tub, “OutFlow.”

6. If there does not seem to be any problem in understanding what they have just done, hand out the assignment sheet that lists different examples of stocks and flows to each student.

7. Explain to the students that the ability to use the definitions of stock and flow and identify stock and flow correctly is crucial to understanding a system.

8. Explain to the students that they are to get into groups of three or four to determine whether the examples on the sheet are stocks or flows. They will work together and discuss the assignment, but each will have his or her own copy of the assignment completed.

Check for Understanding:

After the students seem to have finished the first couple of examples, take the first few up orally together to see if the students have understood the concepts of stocks and flows.

Closing:

Review what you have taught this class. Explain to the class the importance of knowing the difference between a stock and flow for their future success with modelling and understanding systems. Tell the class that next day they will be looking at the symbols for stocks and flows used to create System Dynamics models on the computer with a program called STELLA.

Independent Learning:

In any remaining time, let the students work at finishing all of the examples. If there is not enough time, the students should take the assignment home for homework.

Definitions:

A stock is an accumulation of something (food in your stomach, dollars in a bank account, blood in a heart).

A flow is an action or movement (a rate of change). If there is a flow of something, there must be an associated build-up or depletion of a stock.

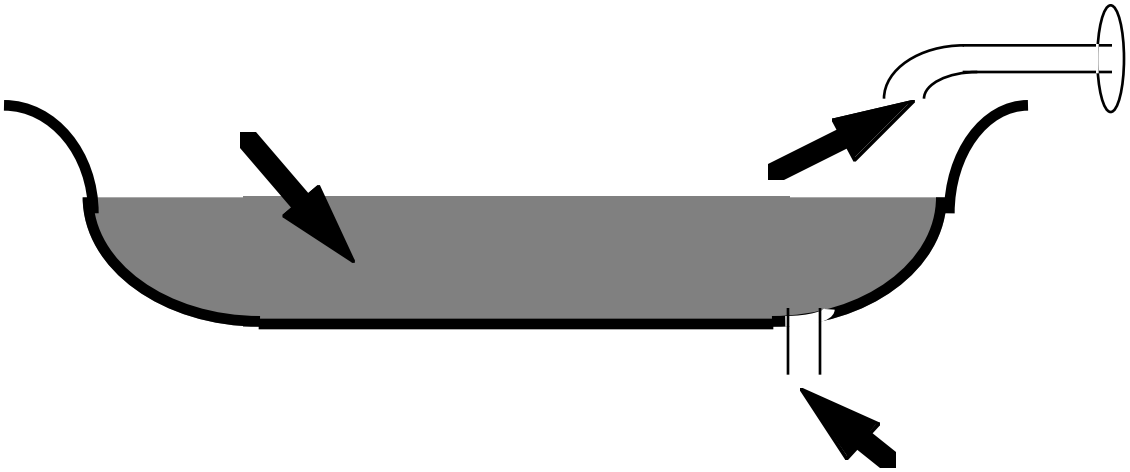
Note 1: Stocks and flows are inseparable. You can't have one without the other.

Note 2: The units of a flow always represent rates of change. In the case of a bank account, for example, the deposit of money is an inflow. In modelling a bank account, one could create a "Monthly Deposits" inflow, indicating that the model assumes deposits happen on a monthly basis. Thus, in this case, the units of the flow would be dollars/month. Other examples of units for flows could be miles/hour or gallons/minute.

The units of a stock always represent a total accumulation, independent of the rate of change. For instance, a bank account is an accumulation of dollars. The rate at which dollars flow into and out of a bank account (measured in dollars/month) affects the total amount of money in the account, but that amount of money is always measured in dollars. Other examples of units for stocks could be miles or gallons.

Lesson Plan Two

The Bathtub Example



Assignment 2: Stocks and Flows

Below is a list of stocks and flows. Using the definitions you have of stock and flow, determine for each example whether it is a **stock** or a **flow**.

1. Inventory of a store
   _____
2. The balance of money in a bank account
   _____
3. Babies born in the U. S. in a year
   _____
4. A country's debt
   _____
5. Incoming orders in a store
   _____
6. The speed of a car on the highway
   _____
7. The amount of exhaust a car emits
   _____
8. The tons of garbage in the dump
   _____
9. The number of cars on the road today
   _____
10. Blood pumped out of a heart to the body
    _____
11. The air pressure in a tire
    _____
12. Withdrawals from your bank account
    _____
13. Your present weight
    _____
14. Gas you are pumping into your car
    _____

Lesson Plan Three

Materials Needed: A copy of the homework sheet from last day
An overhead projector
Acetate copy of "Modelling Shapes" (make one)

Anticipatory Set: Ask the students what they learned last class or through doing the homework.

Objectives: By the end of the class, the students will have:

1. spent time discussing the answers their peers came up with for the assignment on stocks and flows.

2. spent time discussing or listening to discussion on the need to understand the stocks and flows in relation to a system and not as individual elements.

3. experienced working with the other members of their class in groups.

4. spent time drawing the shapes they are going to use to make pictorial models of any systems they will examine.

5. spent time drawing simple models using the shapes of stocks and flows they have seen in today's class.

Instructions:

1. Ask the students what they learned during last class or through doing the homework. This will act as a review and also as an indication to you that the students spent time thinking about the nature of stocks and flows when they are analyzed in isolation.

2. Tell the students to get out the homework sheet on stocks and flows and take up the assignment with the class. This should allow for discussion as there should be some disagreements on the more difficult examples in the assignment.

3. Ask the students if it would have been easier if the assignment had been simply a list of stocks for which they had to determine the inflows and outflows. Discuss their comments.

4. Emphasize the need for one to know what they would like to measure in a system before beginning to model the system.

5. Emphasize the need for a more complete picture of things in all parts of life. Discuss a simple example of an experience they know of where a person made a decision after hearing only one side of a story.

Method:

1. Ask the students to get out a piece of blank paper.

2. Put up the overhead slide called “Modelling Shapes”.

3. Explain to the class that they will soon be using the computer to draw their models. Explain that the program that they will use to draw models is called STELLA. Explain that STELLA uses the shapes shown on the overhead slide to represent Stocks and Flows.

4. Have the students copy what is on the overhead slide onto their blank pieces of paper.

5. Once they have copied the shapes, ask them which shapes they think represent Stock and Flow. Label them appropriately and have them do the same.

6. Ask the class if they have any questions about the shapes. Someone should ask about the cloud at the beginning or ending of the flow. The following is a good explanation of why clouds are necessary in models.

> Clouds show the boundary of a model. They represent elements of the model which are of little concern to the purpose of the model. In fact, clouds are completely unrealistic inasmuch as they represent infinite sources for inflows or infinite sinks for outflows. Naturally, there is no such thing as an infinite source or sink in the world -- everything has a limit! However, the specific limit for a particular element in the model may be of little concern to the model's purpose, and therefore the modeller may choose to represent that element with a cloud.
>
> In modelling, we want to simulate a situation to predict behavior. Therefore, it is critically important to know what you are trying to find out before you begin to model. A clear vision of what you want to find out makes for a clear model that does not contain unimportant elements. This is why clouds are necessary -- they help to define and isolate what is important in the model in terms of what it will show.
>
> In the example on page 15 showing a simple model for an order and inventory control system, there is a flow labelled "Orders" with a cloud on the left side of the flow. The cloud represents an infinite source of orders. In this case, the modeller has chosen to ignore how and where orders originate. The explicit assumption is that there is an infinite source of orders out there somewhere in the world. Clearly, this is an unrealistic assumption; there is no such thing as an infinite source of orders. However, the assumption may be perfectly valid for the modeller

if he or she is solely trying to determine the behavior of the order and inventory control system. In such a situation, how and where orders originate is not necessarily important. As always, the structure of a model depends on its purpose.

Guided Learning:

1. Now that the students are equipped with the proper shapes for modelling stocks and flows, hand out the assignment sheet and tell them to get into their groups and discuss, draw, and label the stocks and flows listed on the assignment sheet using the same shapes as the computer program.

2. Give the students a set amount of time that they will have to discuss, draw, and label. Explain that they will be putting their drawings on the board.

Check for Understanding:

When they have completed the group assignment, if there is time, you can have them draw their models on the board for you and the class to evaluate.

Closing:

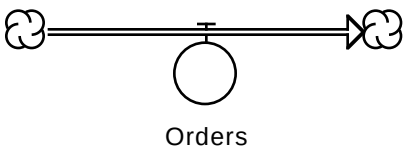
Recap what you have done this class and remind them that they have used these shapes to create their models so that they will be familiar with them when they begin to use the computer modelling program. To finish this class, tell your students that next class they will be learning about feedback.

Independent Learning:

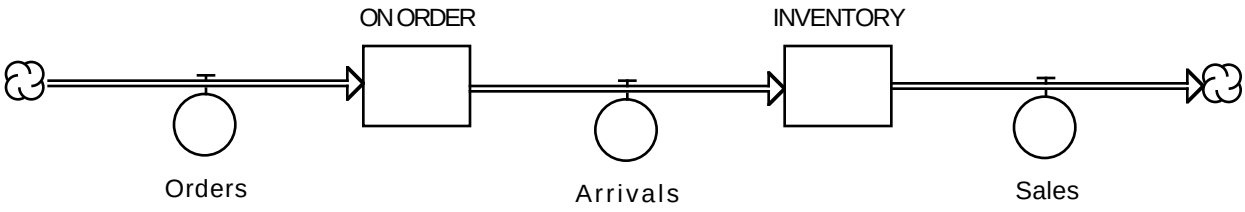
Give them the homework sheet to get them started thinking about feedback.

Lesson Plan Three

Modelling Shapes (from STELLA)



Example of how the two shapes go together:



Lesson Plan Three

Assignment Sheet

Drawing Stocks and Flows

Using the STELLA modelling shapes for stocks and flows, draw the simple models listed below.

1. Population/Birth Rate

2. Pollution/Pollution Rate

3. Bank Balance/Interest Payment Rate

4. Bank Balance/Monthly Salary

For a challenge, try these where there are two flows.

1. Computers/Buying Rate/Selling Rate

2. Nuclear Weapons/Building Rate/Disarmament Rate

3. Library Books/Check out Rate/Return Rate

4. Trees/Growth Rate/Destruction Rate

Lesson Plan Three

Homework Sheet

What is the dictionary definition of "feedback"?

Give an example of feedback.

The thermostat that runs the furnace or air conditioner in your house is a simple example of how feedback works. In a short paragraph, try to explain where feedback plays a role in keeping your house at the desired temperature, regardless of the weather outside.

Lesson Plan Four

Material Needed: A copy of the homework sheet from last class
A blackboard
Copies of the homework sheets for this class

Anticipatory Set:

Write this on the board: **Goals for the day**

1. Learn two new modelling shapes
2. Assign numerical values to stock and flows
3. Understand "feedback"

Objectives: By the end of class, the students will have

1. added "connector" and "converter" shapes to their "Modelling Shapes" page from last class.

2. spent time creating models, assigning numerical values to flows in simple models trying to predict the behavior of the systems, and drawing graphs to display the behavior of the simple systems.

3. shared their findings on feedback with their classmates.

4. written one accurate definition of feedback and drawn one simple feedback loop diagram which they will use in their modelling experiences.

5. spent time listening to explanations and examples of systems that contain feedback.

Method 1:

1. Referring to what you have written on the board, explain to the students the three things they will be doing or learning about during this class.

2. Explain to the class that there are two more aspects to the computer program that they must understand before they use it. Have the students turn to their page on Modelling Shapes from last class. Have them draw a connector arrow and have them label it as "connector". Explain to the class that this is another shape or symbol they will use next class with the computer program "Stella." The function of connectors is to link symbols together to show relationships between elements in a model. Then draw a "converter" symbol. Explain that converters are simply used to make models easier to understand. Converters allow the modeller to split up the model to make it more flexible and easier to change later. See the STELLA manual for additional information on connectors and converters.

Method 2:

1. Indicate that you are moving on to the second "Goal for the day." Ask the students this question. "If you worked in a store and wanted to draw a model of how your inventory system worked, what else would you need to make the model seem real and be useful?"

   (At this point, you are wanting the students to realize that real numbers would help these models really work. You should explain that the computer program allows you to insert values or numbers into the model so it can create a graph for the modeller to examine to see what kinds of behavior result from the model and the way it is designed. Explain that if you have a number in the stock and a rate of increase or decrease, then your stock will grow or deplete depending on how the feedback and flows work. Over time, the changing value of the stock can be graphed and those graphs quickly tell us a lot of information. Explain that STELLA creates graphs for us to show us how the system is working and that STELLA can only create graphs for us if we assign numbers and rates to our stocks and flows.)

2. On the board, draw a simple model of a bank account where there is only an inflow. Ask the class, "If your bank balance is presently zero, what will happen to the stock after seven days if we assign the flow a rate of increase at $2 a day?" Have them answer while you draw a simple linear graph on the board showing the bank account increase to $14 after 7 days. Reinforce to the students that the inflow is a rate of change over time (in this case, $2/day) whereas the stock is an accumulation (in this case, an accumulation of $).

Check for Understanding

Give the students the simple examples below for which they should attempt to predict the results. Have them work in groups to decide what the stock and flow will be, draw the simple models, predict the results, and graph the results. In their predictions and graphs, students should focus on the general system behavior (i.e., graph lines going up and down at the appropriate times), not the precise values of the numbers in the system.

Note: In the language of System Dynamics, the simple behavior graphs the students draw are referred to as "reference modes." The term is appropriate because these graphs represent how the students think the system will behave (in other words, their modes of reference). Reference modes are extremely valuable learning tools once students begin to model systems on the computer. Before running a computer model, students should **always** draw a reference mode to predict system behavior. The differences between the model's output and the student's reference mode lead to questions that must be answered before a student can fully explain the system's behavior.

Even without computer models, however, reference modes can be valuable tools for discussion in the classroom. For example, you can get two students

to draw their reference modes on the blackboard. Although this teaching method can be an intimidating experience for students (and should be used carefully), the class can benefit from a discussion of the differences between the two students' reference modes.

Examples:

a) Garbage in the dump with the inflow rate of dumping greater than the rate of decomposition

b) Population of a country with the rate of births greater than the rate of deaths

c) A person's weight with the rate of consumption lower than the rate of calories burned

Circulate from group to group and see how well they understood the concept of adding numbers to the models and graphing the results.

Have each group draw their model and graph on the board. Have one person from each group explain why the group believes its results.

Method 3:

1. Indicate that you are moving on to the third "Goal of the day." Ask the students to get out their homework assignments.

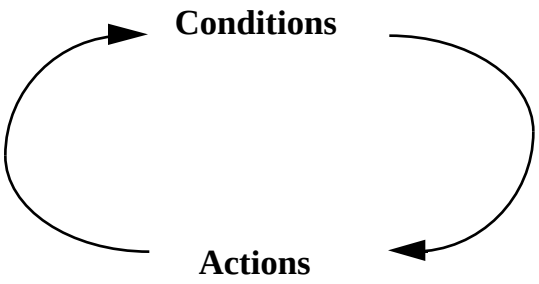
2. Have each student read his or her dictionary definition of feedback to the class. On the board, write the important words each student adds to the first student's definition.

3. When the board is full of the different definition offerings, discuss with the class what they have discovered about feedback, give them a few examples of feedback, and tell them that they are going to use the following definition for their modelling purposes. Write it on the board.

Feedback: A feedback relationship is a closed-loop circle of cause and effect. Feedback always runs from stocks to flows and back to stocks again. This is because stocks are conditions. Once conditions are seen and understood, they give rise to actions, or flows of activity. Flows, in turn, change the original conditions and the feedback loop continues …

4. In the space at the bottom of their homework sheets have them draw this simple diagram to help them understand feedback.

THE SIMPLEST FEEDBACK LOOP



5. Have your students refer to the earlier assignment entitled Stocks and Flows. Ask them to look at the examples and decide which ones they might be able to use as situations that could be modelled with some type of feedback occurring.

6. With suggestions from the class, draw a couple of simple models and include feedback. Draw the feedback loop with a connector arrow like the one used in STELLA.

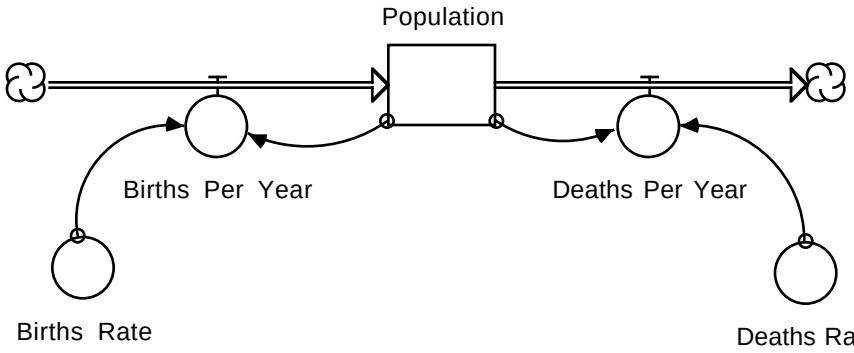
   Note: You will find lots of good examples of simple models with feedback in Road Maps.

7. When you have discussed, analyzed, and drawn the two examples with their feedback loops, hand out the homework assignment.

Independent Learning

Have the students go home with the assignment that encompasses all that they have learned so far.

The model you are hoping the students will draw for homework is shown below.



The model actually has two feedback loops. The first feedback loop involves the number of births per year. The feedback in this loop relates the number of births to the total population -- naturally, the number of people born in any year ("Births Per Year") is related to the total population. The converter labelled "Births Rate"

is a statistical measure of the birth rate as a percentage of the population. Use the value 0.03 (or 3%) as the "Birth Rate" value in your model.

A second feedback loop exists to determine the number of deaths per year. Use the value 0.02 (or 2%) as the "Death Rate" value in your model.

In a situation where the rate of births per year is greater than the rate of deaths, the total population grows exponentially -- an excellent example of a positive feedback loop.

Take notice of the Births feedback loop. The structure of the Births feedback loop is very similar to the structure of the feedback loop in the bank account model used in lesson plan five. Both loops demonstrate positive feedback and together provide a good example of how similar structures appear in vastly different feedback systems.

Lesson Plan Four

Homework Assignment 4

Here is your assignment:

1. Revisit the Population model discussed in class. Try to determine where there is feedback in a Population system and add the feedback to the model. Hint: Focus on the factors that determine how many births and deaths occur in one year.

2. Draw the feedback using the appropriate symbols from STELLA.

3. Taking the feedback into consideration, fill in numerical values for all the model elements and draw a graph to predict how the system behaves.

4. In a paragraph, describe the reasoning behind your prediction of the behavior shown in your graph.

5. Show your work in the space below.

Lesson Plan 5

Before this lesson plan can be used, the teacher has to give some thought to equipment and facilities. Ideally, the setting for this lesson should be in a computer lab or a room that has at least five computers. The number of required computers will vary depending on the class size. Of course, computer availability will also dictate the number of copies of STELLA needed. Teachers can demonstrate the first part of this lesson with an overhead computer screen projector or (depending on class size again) simply have the class gather around a computer. If neither of these things are possible, the copy of the screen can be transferred to acetate and projected for all to see.

Material Needed An overhead projector
Acetate of STELLA screen
Copies of STELLA screen for students
Macintosh computer(s)
STELLA software

Objectives

By the end of class, the students will have

1. seen and labelled an example of what a typical screen looks like when one is modelling with STELLA.

2. watched their teacher use STELLA to draw and run a model on the computer.

3. worked with their peers to use STELLA to draw and run a simple model on the computer.

4. presented another student's computer model behavior to the rest of the class.

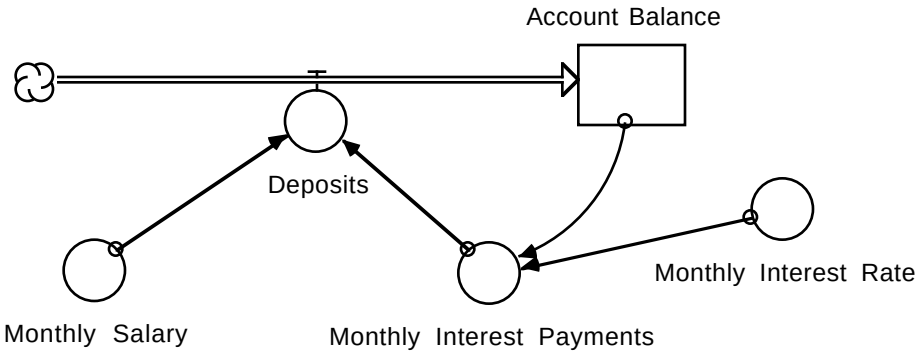
Method:

1. Depending on the route you plan to take, before the students come into the class, you should have the computers on and STELLA running. Have the acetate of the STELLA screen on the overhead projector.

2. Hand each student a copy of the screen picture. Explain to the class that this is the screen they will see when they use STELLA to create and run their models.

3. Have the students get out a pencil and go through each of the parts of the screen having them label the function of the icons and menus. If you have the computers running, it will be easier to demonstrate the function of each icon and menu option.

4. With their pictures completely labelled, you can tell the students that you will be drawing and running a simple bank account model for them. Go to the computer and draw the model below.



5. Assign these values and equations to your model. Note the units of the values and equations are shown in italics in brackets. Do not attempt to type these units into STELLA.

Stock: Account Balance = 0 *(dollars)*

Flow: Deposits = Monthly Salary + Monthly Interest Payments
(dollars/month)

Converters: Monthly Salary = 200 *(dollars/month)*
Monthly Interest Rate = 0.1 *(percentage; no units)*
Monthly Interest Payments = Monthly Interest Rate * Account Balance *(dollars/month)*

6. Select the graph icon and create a graph to display the Account Balance.

7. Select Run… from the Run menu and display the graph. Set the model to run for 120 months.

8. With the graph on the screen, go to the blackboard and draw the model. Have the students draw the model you used in their notes and copy down the values and equations assigned to the stocks and flows. Have them also draw the graph in their notes.

Instructions:

1. Organize the students into groups according to the equipment you have.

2. Ask students to get out their homework assignments from the previous class. Have them go to a computer with their group and attempt to draw (one at a time) the model they drew for homework.

3. Tell them that by the end of class, each student must

    a) have drawn the model they drew for homework

    b) have assigned values to their stocks and flows

    c) have attempted to run their model

    d) have written a description of what happened when they ran their model as compared to the prediction they had drawn for homework

    e) be able to (if picked by you) describe what happened with another student's model (from their group) to the rest of the class

4. Circulate and check for understanding.

5. At the end of class, collect their homework from the last class and their written descriptions of what happened when they ran their models.

Independent Learning

Tell the students to be prepared next class to explain another student's model to the rest of the class.

At this point, you should know what things still seem to confuse the students, where students need more practice, and where you want to head with your own subject examples. Good luck!

Lesson Plan Five

Picture of STELLA Screen