Paper Clip Simulation
A Simple System

Purpose
- To explore the essential components of a simple system and model by using a simulation activity.
- To collect and analyze data produced during the simulation and translate the data into a 1-box model that can be manipulated.

Overview
Through a simulation activity in which students act out the paper clip distribution system, students will take part in a simple system. As a result of the simulation, students will identify and analyze the basic parts of systems including input flows, output flows, and stocks.

Student Outcomes
Students will be able to:
- Simulate a basic system
- Collect/record data in tables and graphs
- Analyze data and describe patterns using qualitative descriptions and mathematical equations
- Create a 1-box model to learn modeling and system terms
- Manipulate variables to obtain an expected outcome

Questions
Content
- How does the paper clip simulation represent a simple system and model?

Science Concepts
Grades 9-12

Scientific Inquiry
- Think critically and logically to make the relationships between evidence and explanations.
- Communicate scientific procedures and explanations
- Use technology and mathematics to improve investigations and communications.

History and Nature of Science
- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models.

NGSS (Black- covered directly, gray-addressed, but not directly covered)
- *Disciplinary Core Ideas*
  - Gr.6-8: ETS1.B, ETS1.C, ESS2.A
  - Gr.9-12: ETS1.B, ETS1.C
- *Science and Engineering Practices*
  - Developing and using models
  - Analyzing and interpreting data
  - Using mathematics and computational thinking
  - Engaging in argument from evidence
- *Crosscutting Concepts:*
  - Patterns
  - Cause and Effect
  - Scale, Proportion, and Quantity
  - Systems and System Models
  - Stability and Change

Time/Frequency
60-90 minutes

Level
Secondary (Middle & High School)

Materials and Tools
- 5 boxes of paper clips
- Class Data Table & projector
- White board/large paper & markers
- Bell or whistle
- Paper Clip Roles: factory worker (5-9), store worker (5), and customer (5-9)- One copy (of any role) per student
- Open and closed sign for store
- Copies of *Student Worksheets & Paper Clip Simulation Data Table* (1 per student)

Prerequisites
- Recording data in tables

Preparation
- Write essential, unit, content questions somewhere in the classroom.
- Sketch a graph on the white board to be used to record the number of clips in the store at the end of each day.
- Set up three stations in your classroom. 1) the factory - includes boxes of paper clips, 2) the paper clip store - includes an

open/closed sign, medium sized table to gather delivery of clips, the white board, and a projector to display the data table and 3) the customers' home base.

- If you plan to extend the paper clip activity with the computer-based model, then conduct the *Paperclip Tutorial Model* (https://exchange.iseesystems.com/public/globeprogam/paperclip-tutorial-model/index.html)

Background

All systems consist of a set of interacting components that, together, form a more unified entity. As an example, an engine, wheels, brakes, transmission and chassis interact together to form a system we identify as a car. In the environment, systems tend to be very intricate because the number of components is often large and the ways in which they interact are complex. To deal with this complexity, scientists often simplify environmental systems by lumping multiple components together and treating them as individual 'pools' and treating the transfer of materials between them as 'fluxes.'

Pools, also known as stocks or reservoirs, represent any place where a given substance can reside. In the carbon cycle, examples of individual pools might include soils, leaves, wood, whole trees and ecosystems or the entire biosphere. Note that these examples overlap and that carbon pools can be grouped together or treated separately. Carbon in trees can be considered a single pool, or it can be divided into leaves, wood and roots. If necessary, these pools can be further subdivided into sugars, starches, and other compounds. Alternatively, trees can be grouped with crops, grasses and shrubs to form a single global plant pool. How scientists make these decisions depends on the questions being asked and the scale of a particular study.

The movement of material from one pool to another is known as a flow, or flux. For example, in the global carbon cycle, carbon moves from the atmosphere to the plant pool through the process of photosynthesis. Hence, photosynthesis represents a flux and is, in fact, one of the most important fluxes in the carbon cycle. The flux of carbon out of this plant pool occurs through the transfer of leaves and other dead plant materials to soils (a process known as litterfall) and through respiration, which releases carbon dioxide back into the atmosphere. These examples are just a few of the pools and fluxes that make up the entire global carbon cycle.

As we proceed, we should keep in mind that no system occurs in complete isolation. Because all things in the universe are in some way interconnected, scientists studying any system must draw artificial boundaries around what they believe are the most important components for a particular study. Although we can view an automobile as a discrete system, it's function relies on external inputs in the form of fuel, parts and other materials, as well as outputs in the form of exhaust and heat. Each of these is affected by processes that occur outside the normal boundaries of what we view as a car. If needed, we could capture these processes by treating cars as subsystems that act within larger systems of transportation, energy and environment. How we draw the boundaries depends on what we are trying to achieve. In the investigations we're about to embark on, we can treat the carbon cycle as a single system, a series of interacting subsystems, or as just a part of the overall Earth system (which also includes the nitrogen cycle, the energy cycle, the water cycle and more).

In order to improve their understanding of a system and its associated components, scientists often use models. Models are used in many fields of study, and can be simple or very complex. Scientists can use models to explore a system over much larger spans of space or time than is often feasible by direct observations. In addition, models can be used to understand the interactions of the numerous components of a system and to consider theoretical outcomes of particular real-world scenarios.

For additional basic modeling and systems information see *SystemsAndModelingIntroduction.pdf* and for PowerPoint slides to present to your class see the *Carbon Cycle Modeling eTraining*. For more resources on the Earth system and teaching about systems thinking see the Resources section below.

What To Do and How To Do It

ENGAGE	Grouping: Class	Time: 10 Minutes

- Ask students to write a response to the following question in their science notebooks: "What is a system?" (or use the Frayer Model template with systems as the center word *See *TeachingTemplates* file)
    - As a whole class, share ideas about the definition of a system

EXPLORE	Grouping: Small Groups	Time: 30 Minutes

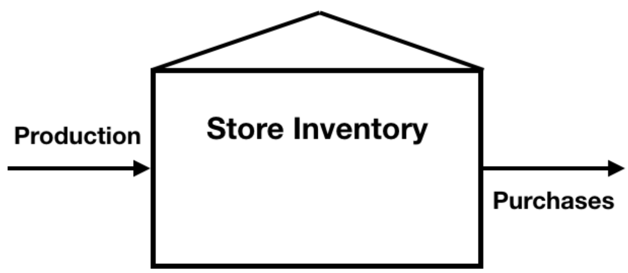
- Tell students that systems are found everywhere, including science, and it is important to have a common understanding of system components and language.
- Explain that the students will be simulating a paper clip business as an introduction to systems. It is critical to emphasize that this paper clip activity will be used as an analogy for a system throughout the study of the carbon unit. As the clip activity is quite simple remind students that the exercise prepares them for more complex modeling and problem solving later.
- Hand out a blank *Paper Clip Simulation Data Table* to each student.
- Read the scenario below to set the stage for the simulation activity. Read with a sense of **humor** to make the activity fun (remember this kinesthetic activity is meant to act as an analogy).
    - "You are the proud citizens of a small town whose stability and prosperity is result of the booming paper clip factory in the center of town. It is your job to study this booming business and to record its activity for several days. [hold up the data table for everyone to see]
    - Some of you will be *factory-workers*. At the sound of the bell every morning each *factory-worker* will have produced 2 paper clips, no more or no less. Paper clips are transported by *factory-workers* to the paper clip store. [point out the location of the store and remind them to deliver to the store in an orderly fashion]
    - Some of you will be *store-workers* and you will carefully count the number of clips produced per worker, number of workers, and total clips produced. [point out the appropriate columns in the data table] Once you've made your counts you will open the store by displaying the open sign.
    - Once the store is open the *customers* will have a chance to purchase clips. Current demand for paper clips is 1 paper clip per *customer* per day. [point out that in order to purchase the clips that the customers will need to line up in an orderly fashion and pick up a clip before returning to their station]
    - All additional paper clips not sold by the end of the day remain in the store and are recounted by *store-workers*. [point out the remaining columns of the data table]. Store workers will announce the day's activities to the public before the next round begins."
- Divide students into 3 groups, which will each have their own role in the paper clip business.
- Hand out prepared cards that indicate students' role and the associated rules (*see Paper Clip Simulation Roles*).
    - Make the *factory* and *customer* groups equal to each other.
    - You will need a minimum of five *store-workers*.
- Direct students to each of the three stations already set-up in the classroom.
- Give students a few minutes to read their descriptions. Tell students to collaborate with other group members to clarify their roles.
- Make sure that the factory has a box of paper clips.
- When *store-workers* are ready they will ring the bell to begin the activity.

- (Note: On the first day the number of clips available will equal the factory delivery of clips because the store inventory is zero on day one. Perhaps students can come up with their own reason the inventory was empty (e.g., grand opening, increased demand, factory vacation).
- Students should write down the results while the *store-worker* displays them on the projector.
- Continue in this pattern until you have completed the cycle 3 times (3 "days" worth of data).

EXPLAIN	**Grouping:** Class	**Time:** 15 Minutes

- Gather students' attention and facilitate a discussion to interpret the initial data:
  - Based on the data table and/or graph…
    - After several days of factory work what do you notice about the number of paper clips available in the store (ie, inventory stock) at the end of each day?
    - Do you see any patterns in your data?
    - How many clips were produced per day? Did this change? Why?
    - How many clips were purchased per day? Remain the same? Why?
    - What is the mathematical equation that describes this pattern in the store inventory?
- Diagram and label the paperclip business as shown in Figure 1, using student input. (*Keep Figure 1 visible throughout the activity. Even use poster board so you can reference it throughout the unit).

Figure 1.



ELABORATE	**Grouping:** Class/Individual	**Time:** 10 Minutes

- Direct students back to their groups.
  - In the second part of the simulation students will understand equilibrium (input = output). To do this, circulate to each group and explain the group's 'new' conditions.
    - Simple option: <u>Only</u> increase the customers' purchase to 2 clips per customer (now factory production should equal customer purchases). <u>Run simulation two more days under the new conditions</u>.
    - Advanced option: Change the output flux to be a fraction of available store inventory (e.g. $0.4 \times StoreInventory_{day-1}$). In cases where the output number of paper clips is fractional, round to the nearest paper clip. Stop the class for a discussion when a logarithmic curve has clearly developed and equilibrium is reached. (See *Extensions* and *PaperClipSimulationSpreadsheet_FractionalExample* for more details.)
  - You may also manipulate the system using the *PaperClipSimulationSpreadsheet* if you feel it is time for students to return to their seats.
- Facilitate discussion to include the additional data.
- Explain that the simulation represents the parts of any simple system.
- Referring back to the schematic depicting the paper clip business (Figure 1), introduce

the standard box and arrow diagram (Figure 2). If appropriate for your students, discuss the interchangeable terminology used in systems (Figure 2). (*Again keep Figure 2 visible throughout the activity and possibly the rest of the unit or year, as a systems reminder).

- Interchangeable Systems and Modeling Terminology:
  - A pool can also be referred to as a stock, box, or reservoir.
  - Arrow, flow, flux, and transfer applies to both inputs and outputs.

- Students use the Journal Questions below, their data table and the class graph to help solidify understanding of how basic systems work (5 minutes). This is also a good place to use the *Mathematical Equations Extension* (20 minutes) - if appropriate for your students.

Figure 2.

EVALUATE	**Grouping:** Class	**Time:** 15 Minutes

- Bring the whole class together and discuss their Journal Questions (*and equations).
- In conclusion discuss how models are used to understand systems (Journal Question # 5). "Mathematical equations (and graphs) are often the simplest models, but computer models (usually a group of equations) can be used to understand systems over greater periods of time and space. Models are tools to understand systems." Use the Teacher Preparation materials: *SystemsAndModelingIntroduction.pdf* and the slides from the *Carbon Cycle Modeling eTraining* to assist you in your discussion.
  - Explain in the context of the box and arrow diagram that the paper clip business is an example of a 1-box model.
- Discuss how all models have limitations and assumptions and the paper clip simulation is no different. For instance, the paperclip model assumes that each factory worker produces an equal number of clips. In addition, one limitation of the model is that we can only calculate the daily paperclip production since the time interval is measured in days. Have students brainstorm limitations and assumptions.
  - *Assumptions:*
    - *Factory only produces and delivers paper clips that are in top condition*
    - *All members of the paper clip business produce, sell, & purchase each day (no sick days or vacations)*
    - *Customers purchase the same number of paper clips*
    - *All additional paper clips not sold by the store remain in the store*
    - *Inventory will always be greater than number of purchases*
    - *Changes in inventory are always linear. Output is not influenced by inventory size.*
  - *Limitations:*
    - *The other essential parts of the paper clip system are not accounted for (e.g., availability of and shipment of steel for production, number of factories, number of stores).*
    - *In our model we have a 1-box inventory. In reality there may be multiple boxes. In fact, the factory could be a box.*

- Students can proceed by answering the *Follow-up Questions* and/or participating in the *Computer Model Extension*.

Assessment

- See *Paper Clip Simulation: Follow-Up* Attached below.
- Have students work in small groups to share their labeled diagrams, definitions, and thinking. Bring class together and discuss the main ideas from their discussions. (*Opportunity to refine their original definitions of: "What is a system?")

Adaptations

- Upper elementary school students (5th and 6th grades) can conduct this activity if it is adjusted to their abilities. One 5th grade class had the students working at the factory actually creating the paper clips out of previously unbent paper clips in order to make the lesson more active. The customer group has the most lag time during this activity. We suggest giving them an extra challenge, such as a word search that relates to the activity and/or the carbon cycle, in order to help maintain their focus. (see *Paper Clip Simulation Word Search- attached below*)
- For students who would benefit from a continued kinesthetic experience run the simulation for varying days using varying inputs, stocks, and outputs. To see clear results we suggest that you alter one variable at a time.

Extensions

- **Mathematical Equations:** Have students develop the mathematical equations behind the paper clip simulation. This is helpful in demonstrating that many systems and models only involve determination of all the variables and basic arithmetic.
- **Fractional Flux/Logarithmic Growth:** During the simulation students found that the paper clip system was controlled by a constant flux where store inventory growth was linear. For more advanced students you could introduce the idea that linear growth is NOT typically observed in nature, and is NOT what we will see later in this systems unit or throughout the year. What is more typical are systems controlled by a fractional flux instead of a constant/linear flux. To demonstrate this concept change the output flux to be a fraction of available store inventory (e.g. 0.4xStoreInventoryday-1). In cases where the output number of paper clips is fractional, round to the nearest paper clip. Stop the class for a discussion when a logarithmic curve has clearly developed and equilibrium is reached (Do this in place of increasing customer purchases to 2).
- **Computer Model:** Use the online *Paperclip Tutorial Computer Model* (link below) to show students how useful computer models are in helping to process information and to prepare them for later modeling activities.
- **Expanding 1-Box Models:** You may challenge students to expand their 1-box models (*Follow-up: Question 4*) into several boxes, describe the math behind their models, or build their models in STELLA online (free from isee Systems). This may turn into an engaging introduction into systems thinking, so let students run with their ideas.

Resources

- GLOBE Earth System Activities in Earth as a System portion of the GLOBE Teacher's Guide.
- *Paperclip Tutorial Model* on the isee Exchange: (https://exchange.iseesystems.com/public/globeprogam/paperclip-tutorial-model/index.html)
- TheCreative Learning Exchange: http://www.clexchange.org/
- A Waters Foundation Project – Systems Thinking in Schools: http://www.watersfoundation.org/
- isee STELLA Online: https://iseesystems.com/store/products/stella-online.aspx

TEACHER VERSION
(Suggested student responses included)

Paper Clip Simulation Journal Questions

1. When the clip inventory was initially increasing was clip production (input) greater than, less than or equal to customer purchases (output)?

Input > Output by 2:1

2. Was clip production (input) greater than, less than or equal to customer purchases (output) when simulation conditions changed?

Input = Output

3. Can you explain why the number of clips remains the same after simulation conditions changed?

Input = Output and the system is at equilibrium. (KEY POINT: Equilibrium does not mean that there are zero inputs and outputs but rather that there is no net gain in clips over time.)

4. Based on your experience graphing the class scenario, describe a new scenario. First select new input and output values (i.e. number of store workers, etc.), then graph Store Inventory Stock for 6 days. Make sure to record below the values you selected and that your graph is labeled correctly.

Input: Factory Workers 2 x Paperclips per Worker 3 = 6 Paperclips Produced per Day

Output: Customers 2 x Paperclips per Customer 2 = 4 Paperclips Purchased per Day

Input – Output = Stock 6 – 4 = 2 Left in the Stock per Day

Sketch Graph Here.

5. We represented this system over a very short period of time (a few days). If the system was returned to Day 1 conditions and if we wanted to investigate how the business was doing in 30, 60, or 100 days how might we be able to calculate production for day 30, 60, or 100 without necessarily running the simulation day-by-day? Describe your answer and reasoning.

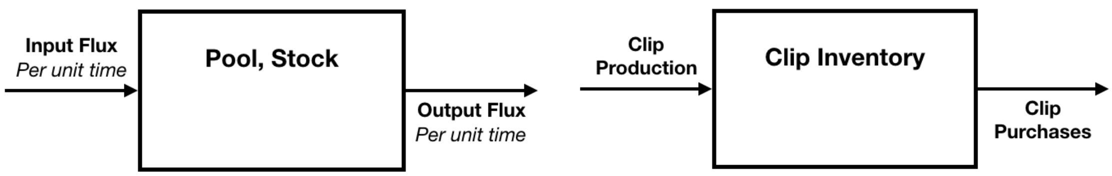
*Mathematical equations (and graphs) are often the simplest models, and when equations (usually a group of equations) are turned into computer models they can be used to understand systems over greater periods of time and space. *This links well with the Extension Activities or other Carbon Cycle Activities.*

TEACHER VERSION

(Suggested student responses included)

Paper Clip Simulation Follow-up

1. Draw a 1-box model in standard box and arrow format (see below) and label the input, output, and stock with terms that illustrate the factory system you just simulated.



2. Answer the following question in a few sentences: In what ways does the paper clip factory simulation represent a simple system and model?

The student responses will vary. However, make sure they are addressing that all systems have components that interact and models have input fluxes, output fluxes, and stocks such as represented by the clip factory simulation. In addition, students are expected to mention that the inputs or outputs can be manipulated or changed. Some students may mention that when inputs and outputs are equal the system and model is at equilibrium.

3. Based on your knowledge of systems and that models are used to understand systems, record <u>in your own words</u> the definitions of a system and a model.

A group of components that <u>interact</u> to produce a whole (in the case of the Earth system) or a specific result (in the case of a machine). OR A collection of interconnected parts that function as a complex whole, through which matter cycles and energy flows.

Models are tools and concepts that help us understand and explain systems that are too complex or difficult to observe, or to comprehend on our own. Models are simplifications of reality.

TEACHER VERSION

(Suggested student responses included)

Paper Clip Simulation Extension - Math Questions

Scientists include equations in simple models to calculate the value of inputs, outputs, and stocks. The incorporation of equations can make life easier! Instead of counting all the clips one at a time you can calculate the factory production of clips each day based on an equation.

1. Develop an equation that would determine the number of clips produced by the factory each day. Make sure your equation is general enough to explain any day of the factory scenario. Check the accuracy of your equation by testing it with actual data collected during the simulation and against the data displayed on the data table. Please show all of your math thinking.

Factory Production

(# clips produced per worker) x (# factory workers this day) = # clips produced this day

1.

$$\textit{Factory Production}_{worker} \times \textit{Workers}_{day\ n} = \textit{Factory Production}_{total\ day\ n}$$

$$FP_{worker} \times W_{day\ n} = FP_{total\ day\ n}$$

Exact values will vary depending on your class - Students should show their work

*Mock Example: (2 clips produced$_{worker}$) * (5 Workers$_{day\ 1}$) = 10 clips produced on day 1 and this matches with value recorded on class data table*

2. Develop an equation that would determine the number of clips purchased by the customers each day. Make sure your equation is general enough to explain any day of the factory scenario. Check the accuracy of your equation by testing it with actual data collected during the simulation and against the data displayed on the data table. Please show all of your math thinking.

Customer Purchases

(# clips purchased per customer) x (# customers this day) = # clips purchased this day

2.

$$\textit{Purchases}_{worker} \times \textit{Customers}_{day\ n} = \textit{Purchases}_{total\ day\ n}$$

$$P_{worker} \times C_{day\ n} = P_{total\ day\ n}$$

Exact values will vary depending on your class - Students should show their work

3. Develop an equation that would determine the inventory stock each day. Make sure your equation is general enough to explain any day of the factory scenario. Check the accuracy of your equation by testing it with actual data collected during the simulation and against the data displayed on the graph. Please show all of your math thinking.

Clip Inventory Per Day

(inventory previous day) + (# clips produced this day) – (# clips purchased this day) = inventory

$$\textit{Inventory}_{day\ n-1} + \textit{Clip Production}_{total\ day\ n} - \textit{Purchases}_{total\ day\ n} = \textit{Inventory}_{day\ n}$$

$$I_{day\ n-1} + CP_{day\ n} - P_{total\ day\ n} = I_{day\ n}$$

Exact values will vary depending on your class - Students should show their work

Name: Date:

Paper Clip Simulation Journal Questions

1. When the clip inventory was initially increasing was clip production (input) greater than, less than or equal to customer purchases (output)?

2. Was clip production (input) greater than, less than or equal to customer purchases (output) when simulation conditions changed?

3. Can you explain why the number of clips remains the same after simulation conditions changed?

4. Based on your experience graphing the class scenario, describe a new scenario. First select new input and output values (i.e. number of store workers, etc.), then graph Store Inventory Stock for 6 days. Make sure to record below the values you selected and that your graph is labeled correctly.

5. We represented this system over a very short period of time (a few days). If the system was returned to Day 1 conditions and if we wanted to investigate how the business was doing in 30, 60, or 100 days how might we be able to calculate production for day 30, 60, or 100 without necessarily running the simulation day-by-day? Describe your answer and reasoning.

Name: Date:

Paper Clip Simulation Follow-up

1. Draw a 1-box model in standard box and arrow format as discussed in class and label the input, output, and stock with terms that illustrate the paper clip system you just simulated.

2. Answer the following question in a few sentences: In what ways does the paper clip simulation represent a simple system and model?

3. Based on your knowledge of systems and that models are used to understand systems, record <u>in your own words</u> the definitions of a system and a model.

4. Create a 1-box model using a system you are familiar with. (Use the back or additional paper.)
   a. Diagram and label your model using the standard box and arrow format.
   b. Run a model simulation similar to the paper clip business. Provide 3 cycles worth of data. (Hint: Start by creating a data table to keep track of: Input Fluxes, Output Fluxes, and Pool Size.)

Name: Date:

Paper Clip Simulation Extension - Math Questions

Scientists include equations in simple models to calculate the value of inputs, outputs, and stocks. The incorporation of equations can make life easier! Instead of counting all the clips one at a time you can calculate the factory production of clips each day based on an equation.

1. Develop an equation that would determine the number of clips produced by the factory each day. Make sure your equation is general enough to explain any day of the factory scenario, as well as any new scenarios that might be presented (Hint: use letters to represent the different variables). Check the accuracy of your equation by testing it with actual data collected during the simulation and against the data displayed in the class data table. Please show all of your math thinking.

2. Develop an equation that would determine the number of clips purchased by the customers each day. Make sure your equation is general enough to explain any day of the factory scenario. Check the accuracy of your equation by testing it with actual data collected during the simulation and against the data displayed in the class data table. Please show all of your math thinking.

3. Develop an equation that would determine the inventory stock each day. Make sure your equation is general enough to explain any day of the factory scenario. Check the accuracy of your equation by testing it with actual data collected during the simulation and against the data displayed in the class graph. Please show all of your math thinking.

4. Determine a way to maintain the stock of paper clips at 25 per day by the end of the day over several days. Feel free to use the backside of your data table to check your strategy. Be able to explain your strategy to the class. Draw another diagram to help you illustrate your new strategy and model.

Name: Date:

Paper Clip Simulation Extension - Paper Clip Computer Model

1. Click [About this Model]

2. Follow along in the model story to complete the following tasks. To move forward through the story, hit the space bar. To move backwards, hit the backspace key.

   a. After three clicks, draw the basic one box diagram used in this computer model (remember, this includes the stock, inflow, and outflow!).

   b. Continue clicking through the story and record the two model converters that influence the model input (converters are represented by a circle and connecting arrow).

   c. What two model converters influence the model output?

3. Once the story has ended, click the **home icon** (on the top right) to return to the homepage.

4. Now select the **Model Map** button – What is the default initial value of workers in this model? (see the numbers inside the converters)

5. Return home and select the **Model Equations** button – Write the mathematical equation for model inflow.

6. Return home and click [Set Initial Conditions]

7. **Model Run 1**
    a. Set Story Inventory to 0 and click [Run Simulation Page]
    b. Look in the **Instructions box**.
        i. How many workers are there?(*hover over the slider to see the number*)

        ii. How many paperclips are produced per worker?

        iii. How many customers?

        iv. How many clips are purchased per customer?

    c. Click to start the model run [Run]
        i. Did the store inventory increase, decrease or remain the same over time?

        ii. What was the initial store inventory? The final store inventory?

    d. Click [View Table of Results]
        i. How does clip production (‘Producing’) compare to customer purchases (‘Purchasing’)?

8. **Model Run 2**
    a. Click [Run Simulation Page] to start a new model run
    b. Under Instructions, <u>change the number of clips purchased from 1 to 2.</u>
    c. Click [Run]
        i. Did the store inventory increase, decrease or remain the same over time?

i. Click . View Table of Results Can you explain why the results of this model run differ from the previous model run?

9. Model Run 3

a. Return to the Run Simulation Page. Change the number of workers from 5 to 4, and return the number of paperclips purchased to 1. Click Run

i. Did the store inventory increase, decrease or remain the same over time?

ii. How could you change only the number of customers so that the system is at equilibrium?
(Hint: Use the arrows at the top of the graph to view the graph on 'Page 2').

iii. Test it out! Change the number of customers to the number you chose and click Run Were you correct? Why or why not?

10. <u>Return both the number of workers and customers back to 5.</u> Click 

.
The graph should look identical to model run 1.

a. If after 5 days, the number of clips purchased increased from 1 to 2, do you think that the system would reach equilibrium?

b. If yes, what would the store inventory be at equilibrium?

c. What would the graph look like? Sketch it below:

Paper Clip Simulation Data Table

Time	Factory Production			Customer Purchases			Store
Day	# of paper clips produced per worker	# of workers today	Total paperclips produced this day	# of paper clips purchased per customer	# of customers today	Total paper clips purchased today	Inventory stock: paper clips remaining today
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							

Paper Clip Simulation Word Search

f	p	r	t	d	p	e	s	f	l	o	w
e	t	a	t	s	y	d	a	e	t	s	r
l	u	i	p	u	l	c	e	u	u	r	r
m	p	k	c	o	t	s	p	o	b	e	o
o	t	u	r	o	o	n	f	o	m	s	s
m	u	i	r	b	i	l	i	u	q	e	t
n	o	y	e	t	u	c	s	t	o	r	e
t	u	u	e	x	t	n	i	u	t	v	r
s	m	i	s	u	o	m	o	y	s	o	t
x	v	e	o	c	e	l	e	o	i	i	l
u	u	i	y	u	s	p	o	n	p	r	u
s	o	q	a	r	t	r	u	f	s	t	t

consumer
equilibrium
factory
flow
flux
input
output
pool
reservoir
steady state
stock
store