**Unit 1 Reading 1:**

**Constructing System Schemas and State Diagrams**

**Why do we need to define a “System”?**

1. In the Unit 1 Observation Stations Activity, you observed many objects and changes. Defining and representing a “system” will help us define the objects of interest during a change. Objects outside of the system are part of the “surroundings.”
2. When observing an event, we need to identify which objects are in the system and outside of the system. This helps us understand the interactions between objects within the system, and how sometimes objects in the system interact with objects in the surroundings. We must also be able to specify the state of the objects in the system at the beginning and the end of the event (and sometimes at intervals during the event as well).
3. To help us define a system, we will draw diagrams called System Schemas. A system schema helps us to represent simply the objects that are interacting during a process or change. Identifying the system carefully will help us decide if interactions are occurring *within* the system during a change, or if objects are interacting with objects in the surroundings.
4. To help us track what’s changing in the system we will draw state diagrams illustrating (at least) objects in the system in their initial and final states.

**Steps in Constructing a “System Schema” Diagram**

1. Think about the event you have observed, and identify the objects that are interacting with each other. How do you know if objects interact? Most interactions occur when there is obvious contact between them. Also, magnets and the Earth can interact with objects they are not touching! These interactions at a distance involve interactions of some object with magnetic fields, electrical fields, or gravitational fields of other objects. We will discuss fields more as we progress in this class.
2. Start making your System Schema by drawing circles to represent each of the objects in your system that are interacting. All objects are represented without any details of their shape or structure. Additional circles are then added to the schema to represent other objects that interact with the objects of interest. Each circle in the diagram should be labeled.
3. Lines are drawn between two circles to represent the fact that these objects interact with each other. Whenever an interaction line ends on a circle, this means that the object represented by that circle experiences an interaction with the object at the other end of the line. These lines have double headed arrows. If object A influences object B then object B must influence object A.
4. Finally, draw a dashed line around the system you are interested in analyzing. Any objects outside of the dashed line are part of the surroundings.

**Example:**

A brick is sitting on top of a book which is sitting on top of a table:



How would you define the System?

**System Schema Example 1:**

We could define the System to include the Brick, Book, Floor and the Earth’s field.

Here is a representation of this system:

brick

book

floor

Earth field

In this case, all the interactions between objects are *inside* the system.

We can use this system schema tool to help us talk about our observations:

1. What objects are in the system?

2. How do objects within the system interact?

3. How do system objects interact with objects in the surroundings?

**System Schema Example 2:**

How would Example 1 change if the system were only the Brick and the Book?

Here is a representation of this system:

brick

Earth field

book

floor

In this case, some interactions of objects cross the system boundaries. The only interaction inside the system is the one between the book and the brick.

This is analogous to interactions on Facebook: if you chose to look only at your group of friends from this high school, you could consider that your system of friends. Any friends from outside of this high school would be considered out of the system.

Again, we can use this system schema tool to help us talk about our observations:

1. What objects are in the system?

2. How do objects within the system interact?

3. How do system objects interact with objects in the surroundings?

**Constructing State Diagrams**

The system illustrated above is *static*—it is not changing. The lab stations you observed were *dynamic* events—there was an observable change that occurred between the beginning and the end of each event.

Let’s introduce change into a similar system to the one represented above—instead of a brick and book on the floor, let’s put them on a table and then lift one end of the table so that the brick and book begin to slide.

Decide what the moving element of your system will be:

1. Brick
2. Book
3. Brick + book
4. Represent object in motion as a dot:

Initial State Final State

Your state diagrams will look like this:

The dots illustrate the change in position of the moving element of your system.

For now, you will only represent the state of the object undergoing change at two points: the beginning and the end of the event. Later on, you may choose to illustrate the change at intervals during the event, for example:

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State diagrams are a useful tool for illustrating the state of a system in which motion is occurring during the event being observed.