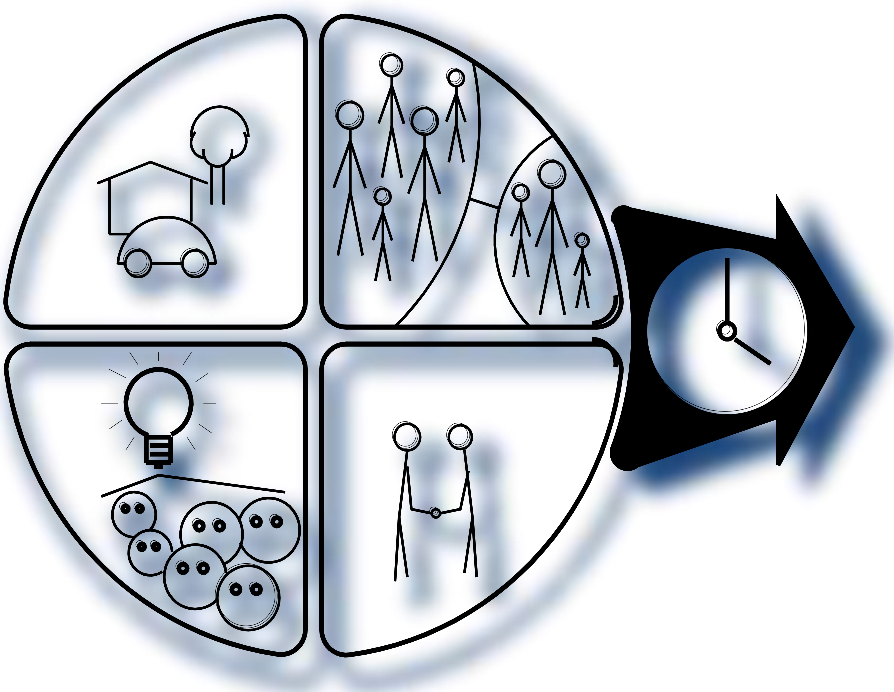
Introduction to

Systems

Social Studies
Humanities
Science



Part 2

Analyzing
Systems

Marion Brady and Howard Brady

Introduction to Systems

Originally "*Connections: Investigating Reality*"

Part 2: Analyzing Systems

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Analyzing Systems

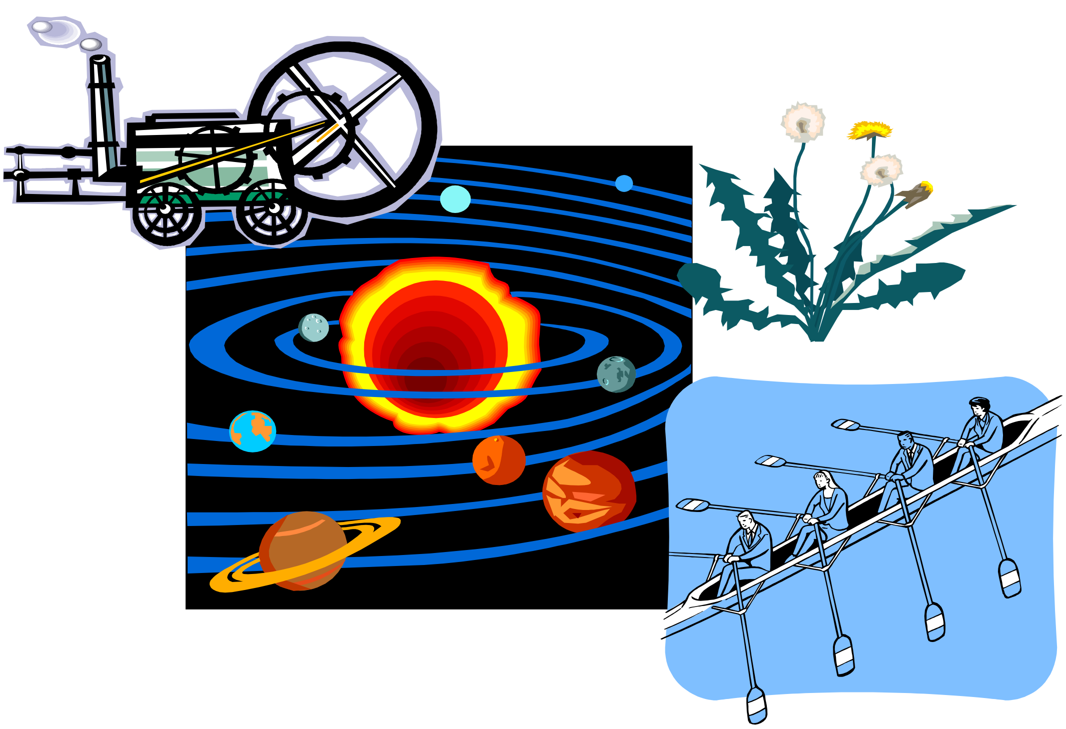
A system is an assembly of related parts interacting in patterned ways. If one part of a system changes, other parts change.

You're surrounded by countless systems:

- Large systems—the solar system, the economic system of the United States, a hurricane
- Middle-sized systems—your local water system, the school library
- Small systems—cell phones, a kid on a bicycle, a burning candle
- Biological systems—an oak tree, your digestive system
- Social systems—a school club, the Navajo nation
- Systems of molecules--your life depends on them.

The universe is a system, as are atoms. *Every science is a study of systems*. Making sense of them is essential to survival. You've begun the process of understanding systems by improving your ability to find *patterns* and *relationships*.

Four systems:



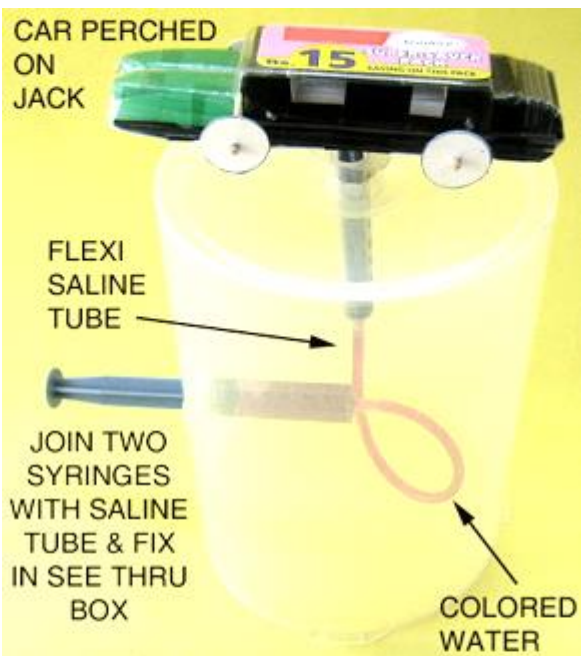
Investigation: Building and Analyzing a System

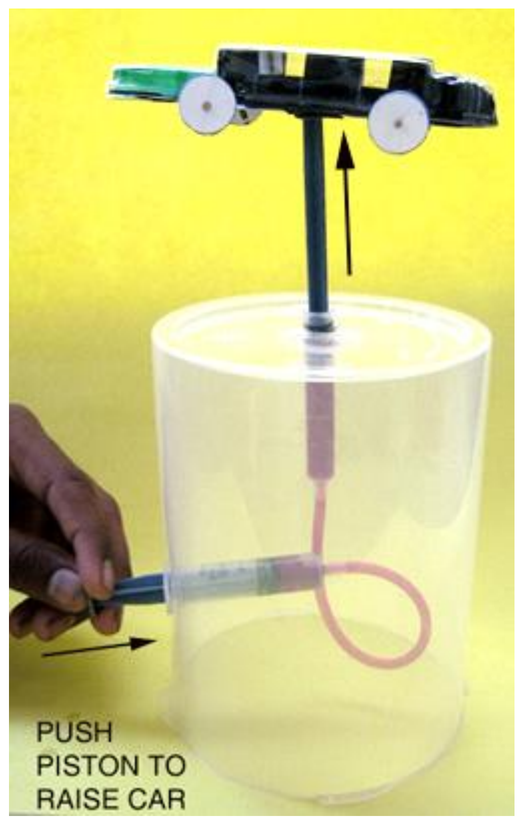
1:   Design a simple system, collect materials, and build it.

Some possibilities:

- Catapult
- Rubber-band-powered toy car or boat
- Windmill-powered hoist
- A device powered by a falling weight
- Water pump
- Something else that moves around, makes noise, or does some kind of work.

The website http://www.arvindguptatoys.com/toys.html dreamed up in India, has lots of plans for “toys from trash, such as:



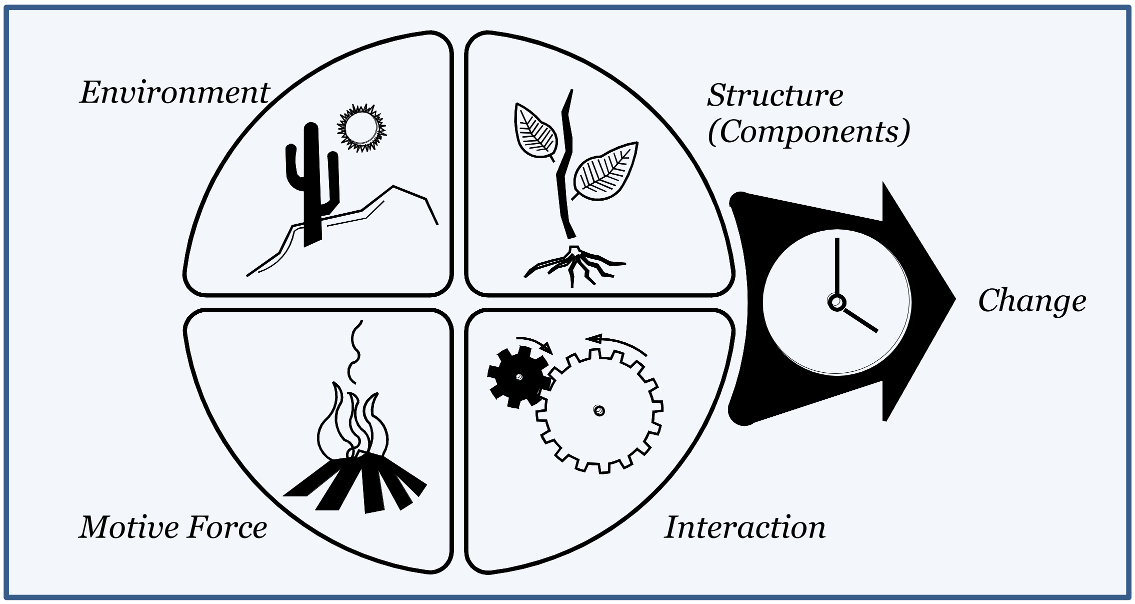


(Toy hydraulic lift designed by K. V. Potdar)

Useful Categories for Analyzing Systems

Five important things to find out when you investigate a system:

- Its environment
- Its structure (the components, and how they fit together)
- Interaction between components within the system, and between the system and its environment.
- Forces that make the system operate
- System changes as time passes.



(This version of the model works well for non-human systems, such as those studied in science. However, for systems with humans as main components, we'll modify the categories to improve their "fit" with those systems.)

2: ***When you've gotten your system working, observe its operation carefully. Look at the definition of a system on page three and describe how your system fits the definition. Note that "relationships" and "patterns" are an important part of the definition.***

3: ***In your journal, write a description that tells precisely how and why your system works. Use pictures and diagrams if they help. Make sure you describe the system's environment, structure, interactions, motive forces, and changes (see above).***

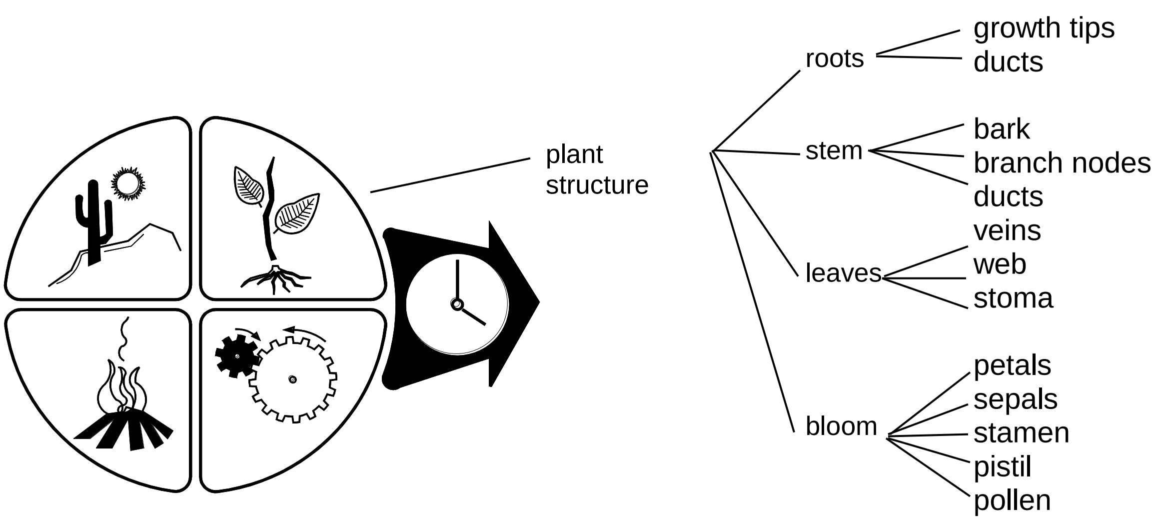
(Clue: Think about the flow of energy into and through the system.)

Investigation: Looking at Other Systems

Choose one or more of the following systems, and use the "Categories for System Analysis" to describe each system and how it works:

- Flashlight
- Pencil sharpener
- Guitar or another musical instrument
- Kite
- Wind-up clock
- Electric coffee maker
- Squirrel
- Dandelion

Build category trees as part of your analysis. The main parts of most systems are made up of sub-parts, and those sub-parts are made up of sub-sub-parts, and so on. Category trees also help you organize your analysis of environments, interactions, and forces.



Every science is a study of systems. If you remember and use the principles of systems analysis, you'll make better sense of whatever interests you.

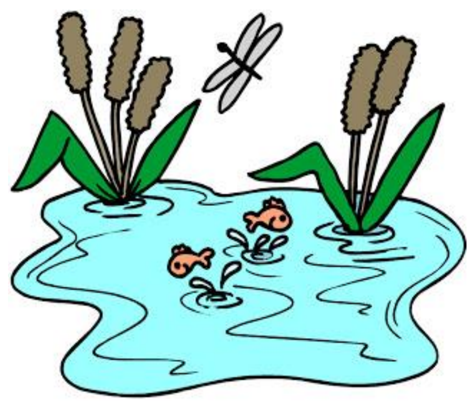
Investigation: Ecology

One possibly confusing thing about systems is the "overlap" of components. If you go to the edge of the nearest pond and look for systems, you'll discover a huge variety. Each living thing—algae, plant, insect, tadpole, etc.—is both a system and a component of larger systems.

Ecology is the study of large systems in nature—investigations such as the following:

- Organisms and their support systems
- Kinds of organisms and controls on their number
- Interrelationships: Predator/prey, food chains, oxygen and nitrogen cycles, etc.

Studying the ecology of even a small environment is complicated—requiring months or years to do thoroughly. However, just beginning a study will suggest systemic links. Working and talking with others about what's being studied will help.



1: ***Choose a small but complex part of your local environment.*** Possibilities: A section of ditch, the edge of a pond or stream, a corner of an overgrown field, vacant lot, or other area with a wide variety of organisms.

2: ***Identify the significant non-living parts of the environment that affect living organisms.*** (Examples: soil, water…)

3: ***Identify the most significant organisms (plants, insects, etc.), within the selected area.*** (If you don't know the name of an organism, describe it with sketches or take picture of it.)

4: ***Estimate the population of each organism within the area.***

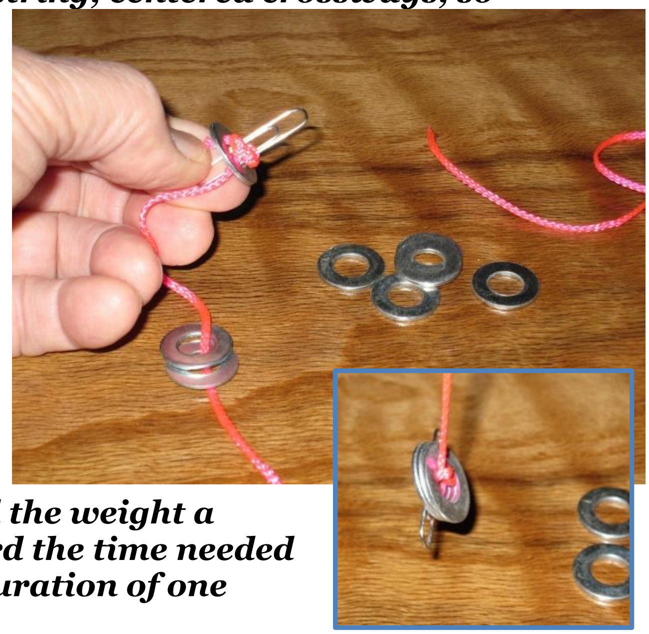
5: ***Describe the ecology of your area using the main categories for system analysis: (environment, structure, etc.) Identify as many interrelationships between elements of the environment as you can, and show interrelationships in a diagram.*** Ask questions Which parts of the environment are food for other parts? Why do populations of various organisms differ? Etc.

Investigation: A Physical System

We've said that every science is a study of systems. A pendulum is an easy physical system to investigate:

1: ***Obtain (1) a piece of cord or string at least 1-1/2 meters or 5 feet long, (2) half a dozen or more identical steel washers with a hole at least 10 mm or 3/8 inch in diameter, (3) a small wire-loop paper clip, (4) a clock or watch that can measure seconds, and (5) a tape measure or meter stick.***

2: ***Tie the paper clip to the end of the string, centered crossways, so washers threaded on the string are kept in place by the clip.***



3: ***Put three washers on the string.***

4: ***Suspend the string so the washers are close to the floor, and the suspension point is at least 75 cm (30 inches) above the floor—higher, if possible. Measure and record the distance from the suspension point to the weight.***

5: ***A pendulum "cycle" is one full swing from one side to the other and back to the starting point. Pull the weight a hand's width to one side, and record the time needed to make ten cycles. Calculate the duration of one cycle.***

6: ***Shorten the string to half the distance measured in (4). Repeat step (5).***

7: ***Add three washers, and repeat (5) and (6). Which has the greater effect on cycle time—length or weight?***

8. ***In your journal, describe the system and how it works. Include environment, components, interactions and motive forces.***

Investigation: Target Area Support Systems

RHRN Project

1: ***Your target area will contain many systems—systems for communicating, for controlling indoor climate, for managing time, and so on. Identify and list as many as you can.***

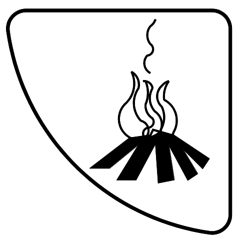
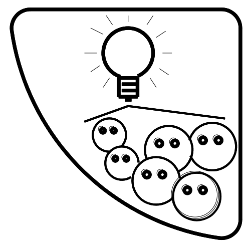
2: ***Choose one system to analyze, using the standard system categories (environment, interactions, etc.).***

Systems with Human Components

You're a component—a working part—of many human systems, some large, some small, some extremely complicated. These systems have a great deal to do with how you think and act. The better you understand them, the more likely it will be that your life works out as you hope it will.

As you study systems with human components, categories for describing and analyzing them will expand. The most important changes will be in "motivating forces." Energy and power are important, but **when humans are involved, ways of thinking drive the system.**

Nothing you can know is more useful than an understanding of the ideas, beliefs, and values that power human systems.

This:  becomes this: 

Motive force *Shared Ideas*

Note: Shared Ideas of the members of human systems are the most important thing that can be known about them, but of course those ideas can't be seen. They have to be inferred from their actions.

Investigation: A System Involving a Human

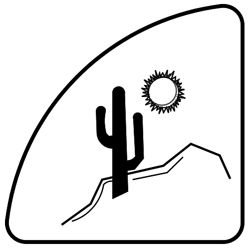
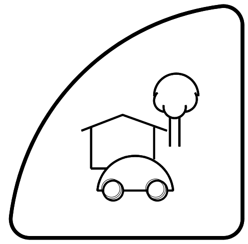
1: A kid on a bicycle is a system involving one human. List in your journal what you think are important things to find out to understand how that system functions.

Discuss this with others. The task is more complicated than you might think, and will take time and careful thought.

2: Organize your list using the main categories for system analysis.

Investigation: Systems with Several Humans

In human systems, the category "environment" expands to include both the natural and the *human-made* environment—*buildings, roads, equipment for transportation, communicating, tools*. "Environment" becomes "Setting."

This:  becomes this: 

Environment *Setting*

1: ***Analyze a simple system involving a few humans working together, such as at a pizza shop or similar small business. Look for patterns and relationships.***

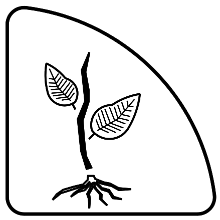
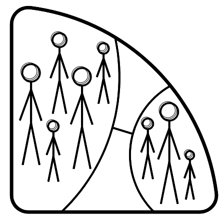
2: ***In your journal, describe the system, using category trees, pictures or diagrams as needed. Identify everything that makes the system work, including important human-made parts of the Setting.***

3: ***In every system, if something significant changes, other important changes follow. Devise and describe a change you think might improve system functioning.***

Investigation: System Analysis of an Historical Account

In human systems, the most important components are, of course, the humans. The analytical category "structure" expands to include all the information about them that has to do with how the system functions—their number, *ages,* male/female ratio, and so on—everything that makes it possible for them to do what they do.

The study of population characteristics is called "Demographics."

This:  becomes this: 

Structure *People/Demographics*

1: Read the following account, then create category trees for the individuals and groups identified.

In 1541, Hernando De Soto and a group of Spanish soldiers he commanded became the first Europeans to see the Mississippi River.[1] Here's part of the account of that event, written by one of his men:[2]

> For three days we tried to find some maize [*Indian corn*] to eat, with little success, and we were very hungry. The Governor [*De Soto*] decided we had to move to find food, even though the wounded men in our company needed rest. So we headed for the native town we'd heard about, called Quizquiz [*probably in what is now southwestern Tennessee or northwestern Mississippi—ed.*]. We marched seven days through a wilderness, with many ponds and thick forests. We were able to cross all the waters we found by fording them on horseback, except some lakes that we swam across.
>
> We arrived at the town of Quizquiz without being seen by the people who lived there, and we captured all the people before they could come out of their houses...
>
> (Continued)

---

[1] Alonzo Alverez de Pineda may have sailed up the mouth of the Mississippi for some miles in 1519, but most experts now think the place he described was Mobile Bay and the Alabama River.

[2] "The Narrative of the Expedition of Hernando de Soto by the Gentleman of Elvas," *Spanish Explorers in the Southern United States, 1528-1534* (New York, 1907) 201-4 (adapted)

There was little maize in the place, so the Governor moved us to another town, a little over a mile from the great river [*Mississippi*]. There we found enough maize to fill our need. The Governor went to look at the river, and saw that near it grew many large trees suitable to make piraguas [*boats*], and a good place for us to camp. We moved, built huts, and settled on a plain a crossbow-shot from the river. We brought there all the maize from the towns we went through. The men began immediately to cut down trees and saw out planks to build barges.

Indians soon came up the river, jumped on shore, and told the Governor that they were subjects of a Great Chief named Aquixo, who ruled over many towns and people on the other shore. The Indians announced that this Chief was coming the next day, with all his people, to hear what our Governor would command him.

The next day the Great Chief arrived, with two hundred canoes filled with armed men. These men were painted with red ore, and wore great bunches of white and colored feathers. They carried feathered shields in their hands, and they used these shields to guard the men who paddled the canoes. The warriors stood erect in the canoes from bow to stern, holding bows and arrows.

The barge that carried the Great Chief had an awning near the stern, where the Chief sat. Other less important Chiefs arrived in similar barges. The Great Chief gave orders from his seat to control the boats.

These boats all came down the river together, and arrived within a stone's throw of where we were camped. The Governor was walking on the river bank with a group of his men, near where the boats stopped. The Great Chief said to the Governor, that he had come to visit, serve and obey him, for he had heard that the Governor was the greatest of the lords, the most powerful on all the earth. The Great Chief said he wished to find out what the Governor wanted him to do.

The Governor expressed his pleasure, and asked him to come ashore, that they might talk more easily. The Great Chief did not answer, but he ordered three barges to come to shore. A large quantity of fish was in the barges, along with loaves shaped like bricks, made of dried fruit pulp. Governor De Soto received these gifts, thanked the Great Chief, and again asked him to come ashore.

Giving the gifts was a test to see if our people could be caught off guard and harmed. However, the Governor and all our people were alert to danger, so the Great Chief had his boats move away from the shore. Our crossbowmen were ready, and with loud cries shot at the Indians, striking down five or six of them. The Indians left in good order, not one leaving his paddle, even if the person next to him had fallen. Shielding themselves, they left the area.

(Continued)

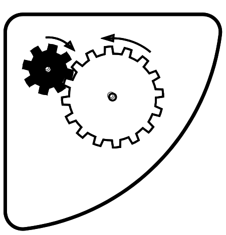
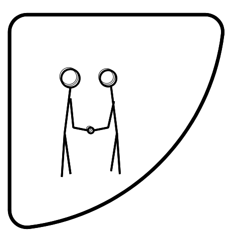
Afterwards they came many times and landed, but when we approached them, they went back to their boats. These were fine-looking men, very large and well formed. With their awnings, plumes and shields, pennants and the number of people in the fleet, they looked like a famous armada of warships.

During the thirty days that we stayed in this location, we built four piraguas. One morning, three hours before daybreak, the Governor ordered twelve cavalry [*mounted fighters*] to go, with their horses, into three of the boats. These were men that the Governor was confident could secure safe passage on the other side of the river, in spite of the Indians, or would die trying. He also sent some foot soldiers who were crossbowmen with them in the fourth piragua, along with oarsmen to row the boats, to take them to the opposite shore. He ordered Juan de Guzman, captain of this infantry of crossbowmen, to cross with his men. Because the current was swift, they went up the side of the river about a quarter of a league [*nearly a mile*], and in passing over the river they were carried down. They landed opposite the camp. Before reaching shore, the horsemen rode through shallow water out from the piraguas to an open area of hard and even ground, which they all reached without accident.

As soon as they unloaded, the piraguas returned. Two hours after sunrise all the people had crossed over. The distance across the river was nearly half a league [*over a mile*]. A person looking across the river could not tell if a man standing on the opposite shore was a man or something else. The stream was swift, and very deep. The muddy water brought along from above many trees and much timber, driven onward by its force. There were many fish of several sorts, most of them differing from the fresh water fish of Spain.

2: Continue your system analysis of the two groups, creating descriptions or knowledge trees for the Setting, including human-made parts of it.

The system analysis category of "interactions" also expands when you deal with human systems. *The most important interactions in human systems occur between people. These are usually patterned—they occur over and over in about the same way.*

This:  becomes this: 

Interaction *Action Patterns*

3: ***Re-read the historical account, listing actions taken by each of the two groups. Group similar actions to form knowledge trees. Identify actions that seem to be patterns.***

4: ***Based on the information provided, what ideas, beliefs, and values do members of each group seem to share? How are they like and unlike your ideas, beliefs, and values?*** (Actions that seem unusual or unfair to you will indicate idea differences.)

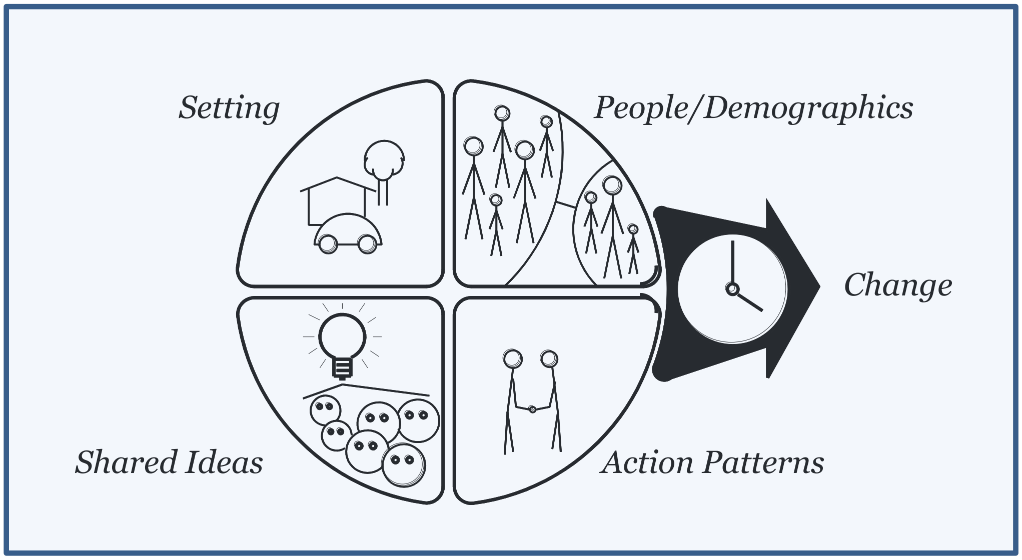
"Discovery of the Mississippi" painting done 1847-1853 by William H. Powell:
http://www.learnnc.org/lp/editions/nchist-twoworlds/1694

In your opinion, how accurate is the painting? The painting's title?

To be fair, the artist probably wasn't familiar with the eyewitness description on pages 11-13 about this event.

The Human Systems Model

You now have the main elements of a Model for investigating any human system or organized human group.



A reminder: Human systems, like all systems, are integrated. Every part relates directly or indirectly to every other part, and a change in any part will cause changes elsewhere. Population increases or decreases, for example, will probably change patterns for work, for obtaining and distributing food, for housing. These, in turn, will cause changes in Settings and in ideas about human relationships. Such changes may occur too slowly to be noticed, so understanding them requires a look at information over time—history.

Investigation: How Universal Is Our Human Systems Model?

News reporters know that to tell a story, they must answer the five “W” questions:

Who? What? When? Where? Why?

Note that these questions “fit” logically with the main categories of the Model.

> **Fire severely damages local dentist office**
>
> TITUSVILLE — A dentist office sustained extensive damage after a Thursday night fire in Titusville, Fire Departments officials said.
>
> Fire crews got a call at 6:11 p.m. for the fire at Christie Dental of Titusville in the 600 block of Country Club Drive, Battalion Chief Greg Sutton said. Crews saw smoke coming from the windows of the business when they arrived on the scene.
>
> Crews extinguished the fire in 30 minutes and no injuries are reported. But the dentist office sustained extensive smoke damage throughout the building and is uninhabitable.
>
> The cause of the fire is under investigation and the State Fire Marshal’s office

1: ***Match each of the five “W” questions with its corresponding Model category.***

2: ***Test the Model by reviewing the “who, where, what, when and why” of human affairs in several sources—news stories similar to the one shown here, a happening described in a history book, an elderly person’s recollection, an incident in your school, etc. In your journal, paste in news clippings or copies of other printed accounts, or write information from verbal accounts, then draw circles around the information that answers each of the “W” questions, and indicate which question is answered.***

Note: The question “Why?” sometimes isn’t answered in news stories, either because the answer is obvious, or because the reporter doesn’t know the answer.

3: ***For each story, identify possible systemic relationships between the components.***

4: ***Dramas and plays model reality but use different words for major categories. What are they?***

Investigation: Target Area Systems That Include Humans

RHRN Project

1: ***Identify and list the significant human sub-groups within your target area.***

2: ***Describe each sub-group in the target area—number of members, age ranges, and other distinguishing characteristics.***

3: ***Using the system Model as a guide, identify major Shared Ideas and Action Patterns for each sub-group in the target area,***

For Teacher/Mentor:

Investigations in this part require considerable advance planning. See descriptions of individual activities that follow.

The first half of Part 2 is grounded in science and technology and gives learners an analytical tool that's missing in most science courses. Science, as presented in traditional textbooks, often comes across as an overwhelming mass of information covered so rapidly it's rarely really learned. There are, of course, exceptions, but what's often missing are overarching organizing concepts that help kids sort out the important from the trivial, organize information usefully, and grasp the centrality to science of discovering relationships between aspects of reality not previously thought to be related.

An understanding of the organizing concepts of systems theory given here, brought to bear on whatever is being studied—molecules, earthworms, volcanos, weather, asteroids, anything—create "puzzles" that can challenge and teach.

Those same system concepts can be applied to societies and other human groups and yield the same benefits. The second half of Part 2 focuses the organizers more sharply on human groups and their behavior.

The length of instructional time required will vary widely from class to class.

Investigation: Building and Analyzing a System

Ideally, teams do the work in class, which of course requires tools—heavy scissors, pliers, wire cutters, small saw, hammer—and materials—wire coat hangers, empty aluminum soft drink cans, wooden blocks, dowels, nails, paper clips, rubber bands, miscellaneous junk, etc.

Chaotic, but memorable.

Alternatively, teams can plan their devices in class, and members can do tool-related tasks elsewhere and bring in pieces for assembly. Even if this is primarily a team effort, some may want to create on their own.

The point, of course, is to make something tangible that illustrates a simple system and its parts. Depending on class age and character, you may choose to have learners do this individually or in teams. Exchanging work or descriptions of work will reinforce the concepts.

Kids may have difficulty with the "environment" category of their system description. Toys require a tabletop or the floor, elements taken for granted and not mentioned. Encourage specificity with questions such as, "Will this work on a grass lawn? Upside down? (Gravity is part of the environment.) Will it work if the temperature is below freezing or above boiling?

Toy boats, of course, require water to operate. The space needed for a test of boat operation will depend on the boat, and should be specified, along with the part of the environment used for launch and retrieval. Identifying the obvious is often difficult.

Investigation: Examining Other Systems

This extends the previous activity. Although straightforward, some learners may have difficulty “filling in the blanks” in some parts of their descriptions. Working in groups will help younger learners. In some cases, outside research may be useful.

Investigation: Ecology

A great deal of evidence and common sense say kids learn more when they’re not confined to seats. If possible, involve teachers whose specializations are appropriate. The logistics of teams of four or five learners working together, each at a different location, may be difficult, likely requiring aides, parents, or others.

Boundaries between fields of study are human inventions that don’t exist in the real world. This activity tackles that problem.

A side benefit of team teaching is the possibility of combining class periods to give teams more time in the field. An initial data-gathering trip to the selected site for a couple of hours is suggested. Data gathering should include notes, photos, sketches, samples (take collection jars), measurements of various sorts, etc. Make sure learners don’t ignore plant life.

Successful field trips raise questions. (How do water striders do it? What do they eat? How long do they live?) At this point, encourage learners to avoid external information, and find out as much as they can directly from nature instead of secondhand sources. Once they’ve gone as far as they can on their own in the time allowed, one can hope that at least some will raise questions that prompt them to check the Internet, the library, or someone knowledgeable.

After the initial field trip, a first attempt at putting together an analysis will almost certainly reveal that the initial gathering of data was inadequate, requiring another visit to the area.

For language arts purposes, the focus should be on effective communication—clear, precise descriptions. Good science requires specificity about what’s not known, separates fact from conjecture and demands honesty, including giving credit when information from outside sources are used.

The activity could, of course, proceed indefinitely. It’s impossible to know everything about an ecological site, so establish a schedule and deadlines. What’s most important is breaking through the barrier created by the too-familiar. Focusing intently on a tiny aspect of reality can make it “strange enough to see.”

Investigation: A Physical System

This one’s far easier than the ecology investigation, and can be done in one or two class periods. The necessary supplies can be brought in by learners or supplied to work teams by teacher/mentor or the school.

One minor point not made in learner materials: For precision, the length of the pendulum should be measured from the suspension point to the center of the weight, not to the weight’s top or bottom.

Learners—one hopes—will be curious enough to try additional tests, such as finding the effects of wide swings as compared to narrow, and experimenting with various pendulum lengths. If so, results should be recorded in journals.

Consider generating graphs to show relationships between pendulum length and the cycle period.

Investigation: Target Area Systems

Every target area contains or is affected by multiple, easily accessed systems. As with earlier investigations, this one may require considerable time depending on the systems being investigated, level of learner interest, etc.

Possible systems for investigation: The target area's climate control, water, electrical, and waste disposal (both sewage and solid waste systems). Identifying energy use and loss may be of interest and significance. What's the source of energy for heating and/or cooling? How does the system work? Where does energy come from? At what cost? What components distribute warm or cold air? Does energy production generate carbon dioxide or other gas as a side product? If so, what kind and how much? Are there other byproducts, e.g. ash? What happens to other byproducts? What's the source of the electrical energy used for light and other energy needs? How much does it cost? How much energy does the school waste?

Analyzing waste disposal systems may be particularly productive, including questions such as: What types of waste are produced? Where does it go? How is it processed? How much is recycled? Where will the waste be when learners are 60 years old?

What communication systems are used by the school? Are links bidirectional or unidirectional? Are they adequate? How might they be improved? Note that communications may be spoken, written, graphic, direct, at a distance, etc. Don't overlook such things as bulletin boards, handouts and bells or alarms as communications systems.

Investigation: A System Involving a Human

For kids, bicycles are more than simple transportation. The point of this investigation is that the real motive force for bicycle operation isn't just muscles operating legs and feet applied to pedals. What goes on in a kid's head is important—getting to a destination, having fun, burning off excess energy, avoiding boredom, or perhaps learning stunts to demonstrate skill and enhance status. Bicycles expand the territory kids "own."

This is the learner's first exposure to states of mind as the most significant aspect of every human-based system. One technique for getting at basic ideas and values is a series of "whys?" when learners give superficial explanations for behavior.

Investigation: Systems Involving Multiple Humans

Observing a fast food or similar retail operation may be difficult if some of the operation is hidden behind equipment or walls. Observation is best done during non-school hours, and should not interfere with the business or customers. The point is to transition the Model's system concept from "environment" to "Setting"--buildings equipment, layouts, tools, and so on.

A possible alternative to the analysis of a fast food or similar business with more accessibility (and probably quicker), could be observing or just remembering a sports team, including those in roles other than players—coaches, equipment managers, referees, etc. Again, the focus is on the way the environment becomes a Setting, with the configurations of venues, constructions (e.g. grandstands, goals, field marking, etc.), and equipment affecting system functioning.

Investigation: System Analysis of an Historical Account

This activity introduces people/Demographics as an element of the Model. The account identifies two major groups—natives and Spaniards. Within each group are various subdivisions—native village residents, natives in boats, further subdivided into chiefs, warriors, paddlers, etc.; Spanish crossbowmen, cavalry soldiers, and De Soto himself. All of this can be depicted in a tree diagram.

The numbers of people involved can be inferred from the account. Historical data may exist to indicate the size of De Soto's forces at this point; if so, we're unaware of it. Having learners work through the logic of estimating the numbers of Spanish men and horses can be an important learning experience. Here are questions to help learners with their estimates:

Based on the account, estimate:

(1) The approximate size of each boat, based on what it could carry
(2) The number of oarsmen it would take to row each boat
(3) When the boat did not carry horses, the number of men, with their equipment, each boat could carry (in addition to the oarsmen)
(4) The speed of the boat
(5) The distance it traveled across the river and back
(6) The number of trips each boat made in the five hours used for the crossing
(7) The possible size of De Soto's forces—men and horses.

Here's our wild guess, for teacher/mentor eyes only; we may be far off from the actual numbers. The learners may do it better than we did.

The Spanish built four boats. From the account, each was big enough to hold three horses and their riders, along with oarsmen. (One carried additional crossbowmen on the first trip.) A boat this size would likely require six or eight men (perhaps more) to row it across the river. When not carrying horses, each boat could likely carry 12 to 21 men, with their equipment, plus the oarsmen.

Each boat rowed up the river nearly a mile, close to shore to stay out of the swiftest current, then diagonally across the river over a mile, so each trip across and back probably required four miles of rowing, perhaps more. As a guess, the average boat speed was probably about a mile an hour or less upstream, and two or three miles an hour across and downstream.

The company would have included additional horses, for De Soto and his officers. If we assume a minimum of four additional horses, and a maximum of eight, we have all the data to do a rough estimate of the size of the Spanish force.

That's a lot of guessing. However, tabulating (oarsmen are included in the final trip only):

	Men (Low estimate)	Men (High estimate)	Horses (Low estimate)	Horses (High estimate)
Crossing 1:	16	20	12	12
Crossing 2:	48	84	--	--
Crossing 3:	30	36	4	8
Crossing 4:	--	106	--	--
Totals:	94	246	16	20

We've assumed only three trips across and back for the low estimate, and four trips for the high. We've also assumed the final one-way trip carried only the rowers (six per boat) plus a few stragglers for the low estimate, a full 21 men plus eight oarsmen per boat for the high estimate. The actual size of De Soto's force is likely to be closer to the low estimate; the final one-way trip may not have required all four boats, complicating the estimating process. The objective is the exercise of thinking skills by learners, not historical accuracy.

The investigation continues by identifying and organizing information about the other three main elements of the Model. When considering Setting, make sure learners include the tools used by each group. Some tools not mentioned can be inferred, such as those used for boatbuilding.

Note: Although unrelated to the main subject, some discussion of the ethics of the explorers and natives is suggested, since those reading the account will almost certainly raise the issue.

The painting by Powell is a romantic view of the event. The passage of the group over ponds, swamps and deep woods made the presence of a large cannon unlikely. Much of the equipment the Spanish had started with was lost to native forces in earlier battles, and the Spanish numbers were decimated in those conflicts.

Investigation: How Universal is Our Human Systems Model?

This investigation underlines the validity of the Model in any in-depth analysis of human events. An optional extension applies the Model to crime scene investigations, likely familiar to learners through countless TV dramas.

Investigation: Target Area Systems that Include Humans

The school (if that's the learning environment) is a microcosm of society, with all the elements of reality identified by the Model. Here, learners begin their moredetailed system-based analysis of the Target Area. It will continue for the rest of the course.