



6-8: Connections *The Nature of Networks*

Curriculum Connections

Life Sciences

- Understand that an ecosystem's balance is the result of interactions and interdependence between the populations and their environment, and that this balance can be altered by a variety of factors, including human activities.

Scientific Connections and Applications

- Understand big ideas and unifying concepts including the relationship between form and function; order and organization; change and constancy; cause and effect.

** Based on the New York State Elementary Science Core Curriculum and the New York City New Standards™*

National Standards

Content Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard C: Life Science

- Structure and function in living systems
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

Content Standard E: Science and Technology

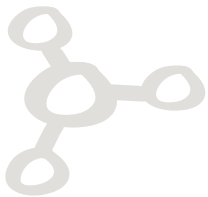
- Abilities of technological design
- Understandings about science and technology

Content Standard F: Personal and Social Perspectives

- Populations, resources, and environments
- Science and technology in society

6-8 Exhibits List

Network Finger Maze
Ropes and Pulleys
Global Observer
Internet Arm Wrestling
Power Grid Network
Music Composition Table
Near
Zooming Maps
The Game of Life
Ant Colony
Pachinko Routers
Train Tracks
Network Building





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Guide Theme

The theme of these guides are based on popular crime and detective show investigations on TV; a mystery unfolds, questions are asked, evidence is gathered, conclusions are drawn. This process is similar to what scientists go through with the inquiry method. For more details see About the Guides.

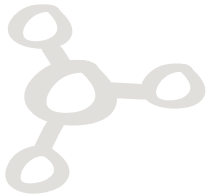


Begin the Investigation At School

A mystery unfolds, questions are asked...

There are several ways you can introduce the topic and start the investigation. Here are some ideas that will help students start thinking about the topic and generate questions:

- How is it possible to arm-wrestle an opponent in Alaska, Pennsylvania or Iowa without leaving New York? (answer at Internet Arm Wrestling exhibit)
- How are a spider's web and a river network like the World Wide Web? (answer at Spider Webs and Braided Streams exhibits)
- How could a tree falling on a wire in Ohio cause one of the largest blackouts in U.S. history?
- Demonstrate one of the Laboratory Activities with no explanation-let the questions begin
- Do one of the Laboratory Activities and facilitate a probing discussion



Prepare for Investigation at the New York Hall of Science

Once students have generated questions around the topic tell them they are going to continue the investigation at the New York Hall of Science.

At this point you may want to begin one of the Continuum Activities. These activities have the following features:

- Vary in length and depth
- Provide continuity and purpose for the visit
- Provide a way of assessing student understanding

Orientation and Planning: If you do nothing else, do this!

Here are five reasons to conduct student orientation and planning before going on a field trip:

1. Students focus on exploring and investigation versus the novelty of the location
2. Students don't have to worry about logistics like restrooms, schedule, eating etc.
3. Students who understand the plan and purpose of the visit are more likely to stay focused
4. Students who have clear goals for their visit are less likely to race from one exhibit to another with little understanding
5. Students who get involved in the planning of the visit, take ownership and are less likely to misbehave

Read more about the Orientation and Planning Process





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Investigation at the New York Hall of Science

Evidence is gathered...

Okay. The class has arrived at the next phase of the investigation. The students have questions and seek answers. Everyone knows what exhibits they should visit and why. Everyone knows the schedule for the day. Students have materials to record findings or work on a Continuum Activity if required.

If all of the above is true, congratulations on a successful Orientation and Planning.

If you are curious about what teachers can do on site, we've put together a little piece called Teacher Role.

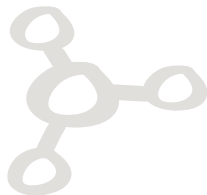


Finish the Investigation Back at School

Conclusions are drawn...

There are several ways you can complete the investigation. Some require less time than others. Here are some ideas:

- Student or group oral or written reports on investigation questions and answers
- Student or group illustrations of visit with answers to questions or mystery
- Do one of the Laboratory Activities
- Complete the Continuum Activity



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Continuum Activities

Continuum Activities are designed to carry through the entire investigation. Some activities require less time than others.

Investigation Map

Description: Detectives will often map out related events, evidence and suspects during an investigation. This helps them get an overall picture. Students can map out their investigations with a concept map. The concept map will help you assess what students learn.

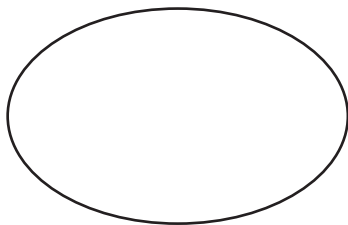
Time: (3)15-30 min. Sessions

Materials Needed:

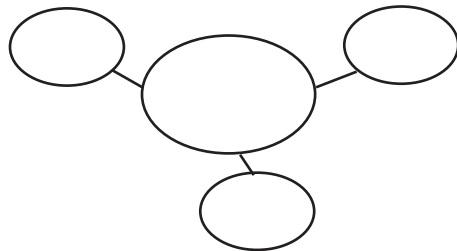
- Blank paper
- Pencils, colored markers

Procedure:

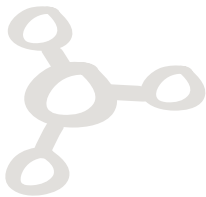
1. Begin with a center circle and write in the name of the main topic. (Students who have difficulty with writing can have an adult assist or draw a representation of the main topic)



2. As students generate questions about the topic, they can add offshoot circles. They can also add circles for facts they know about prior to the visit to the New York Hall of Science.



3. When students return from their investigation at the New York Hall of Science they add additional circles of information. Their final map should reflect everything they know about the topic. Teachers can easily assess what is learned based on how the map develops.



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Investigation Journals

Description: Investigation journals provide a way for students to record their questions and findings throughout the investigation.

Time: (3) 15-30 min. Sessions

Materials Needed:

- Blank or lined paper
- Pencils, pens or colored markers
- On-Site Investigation Handout (print out from this web site and make copies)
- Zip-lock bags (for on-site handout only)
- Soft yarn or thick soft string (for on-site handout only)

Procedure:

1. Ask students if they have ever seen a detective take notes when trying to solve a mystery. Tell students that as “science detectives” they too will make a record of the mystery.
2. Have students begin their journal or report with questions that are generated when they Start the Investigation at School.
3. Students who do not have writing skills can make a large question mark and draw representations of their questions. If an experiment or demonstration is done, non-writing students can sketch what they observe.
4. Students with writing skills can list their own and other students questions in their journal.
5. We strongly advise students not bring journals to the New York Hall of Science where they can get lost. We have provided an On-Site Investigation Handout that can be copied if students want to record observations or make sketches.
6. When students return from their investigation at the New York Hall of Science have them write answers to questions or draw what they observed.

Science TV- Investigative Reporters

Description:

In this activity, students plan and produce a TV show featuring investigative reports on the topic. This is a cooperative learning activity that integrates language arts, science and technology. There is a significant amount of writing involved, however students who are not prolific writers can also contribute as camera people, script supervisors, directors and on-camera reporters. Students will video tape at school and at the New York Hall of Science so pre-planning is essential for this activity.

Time: (3) 45 minute sessions (writing)

- (1) video shoot at school
- (1) video shoot at the New York Hall of Science
- (1) 45 minute session (writing)
- (1) video shoot back at school
- (1) 30 minute session for viewing final TV show

Materials Needed:

- Video camera
- (1) video tape per student group
- External wired microphone for camera (optional but suggested for good audio)



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- TV
- Cables to run camera to TV for viewing
- Student internet access (optional for research)
- Lined paper and pencils
- Large plain paper and markers (cue cards)

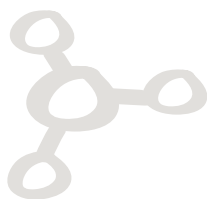
Procedure:

First Session-Planning

1. Tell students they are going to plan and produce a TV show with investigative science news stories that are 4-5 minutes in length.
2. Divide the class into groups of four or five students.
3. Have students or the teacher choose a writer/script supervisor, camera person, director and on-camera reporter for each group.
4. Tell students about the various roles in the production team:
 - Writer-writes groups ideas for script, makes revisions
 - Cameraperson-operates camera
 - Director-supervises camera person and on-camera reporter, calls for action and cuts
 - Script Supervisor-makes cue cards for on-camera reporter, makes sure script is followed
 - On-Camera Reporter-person who reports and appears in video
5. Tell students that everyone the group will work together to create the script.
6. Remind students of the topic of study and the trip to the New York Hall of Science.
7. Instruct students to begin to create questions around the topic for the news show. They may want to create questions for interviews with New York Hall of Science “Explainers” too.
8. Tell students to watch the local news on TV so they can observe how news reporters do their job.

Second Session-Location Scout and Scriptwriting

1. Tell students they are going to do a location scout of the location they will be shooting at the New York Hall of Science. Scouting the location will help them think of more questions and give them ideas for what to shoot on location.
2. Make prints out of the exhibits the class will visit at the New York Hall of Science OR have students access the exhibits online themselves.
3. Once students have become familiar with the exhibits, allow time for more scriptwriting. Make sure scripts have the following components:
 - Introduction to the report (name of reporter, where they are, news headline)
 - Questions the investigative report will answer
 - Conclusion (to be done after video shoot at New York Hall of Science, comment, opinion about answers, reporter sign-off)





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Third Session- Rehearsals and Final Script

1. Remind students about the various roles in the production team:
 - Writer-writes groups ideas for script, makes revisions
 - Cameraperson-operates camera, responsible for video tape
 - Director-supervises camera person and on-camera reporter, calls for action and cuts
 - Script Supervisor-makes cue cards for on-camera reporter to read, makes sure script is followed
 - On-Camera Reporter-person who reports and appears in video
2. Have groups rehearse their roles using the scripts. (Camera people can use their hands to frame shots)
3. Advise groups to make script revisions if they notice problems during rehearsal.
4. Rehearsals can be done in front of whole class or in individual groups depending on your classroom space and noise level.
5. After rehearsal have groups meet and finalize the pre-New York Hall of Science script.

Homework

Have groups give script supervisor the pre-New York Hall of Science script so they can make cue cards. (Script supervisor can ask others to help make cue cards too)

Video Shoot at School

During this session each group will shoot the introduction to their news story. Each group will have their own video tape. Make sure each group tape is labeled. If possible you may want to have groups shoot in a quiet separate location from the others or schedule group shoots during breaks in the day. If the entire class is present during shoots, make sure the others are quiet and don't distract the shooting. After shooting make sure camera people return the group tape to the teacher for safe keeping.

Video Shoot at the New York Hall of Science

1. Make the shooting schedule for the day.
2. Allow 15-20 minutes for groups to shoot in their location.
3. Choose a central location for production groups to meet the adult who will have the video camera and group tapes.
4. Make sure production groups stay together at the New York Hall of Science and Chaperones know the schedule for the day.
5. If students plan to interview a staff "Explainer", locate the Explainer in the area before shooting and ask for their assistance and cooperation for the shoot.
6. After shooting make sure camera people return the group tape to the adult for safe keeping.

Conclusion Script Back at School

1. Production groups will need to write the conclusion to their video script after their New York Hall of Science video shoot.
2. The conclusion should include a summary or opinion of the overall story as well as the reporter sign off.



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3. Allow production groups to review their video footage (if necessary) so they can form opinions or summaries.
4. Have script supervisors and others in the group make up the final cue cards and conduct short rehearsals.

Video Shoot at School

During this session each group will shoot the conclusion to their news story. If possible you may want to have groups shoot in a quiet separate location from the others or schedule group shoots during breaks in the day. If the entire class is present during shoots, make sure the others are quiet and don't distract the shooting. After shooting make sure camera people return the group tape to the teacher for safe keeping.

View the Show

Hook up the camera to the TV and run the group tapes from the beginning. Enjoy the show.

Become an Explainer

Description: Students practice observation skills and investigate one exhibit with the goal of being able to explain it when they return to the classroom. Students can choose a variety of methods to explain and make presentations.

Time: (3) 45 min. Sessions

Materials Needed:

(per student pair)

- Interesting objects for student observation that will fit in a lunch bag
- Lunch bag
- Print outs of On-Site Investigation Handout (optional suggestions)
- Variety of craft materials (pipe cleaners, popsicle sticks, straws, string, paints)
- Variety of clean, household recyclables (meat trays, cardboard tubes, aluminum foil, plastic wrap)
- Any other odds and ends students can construct with
- Poster board or paper
- Markers, crayons, colored pencils

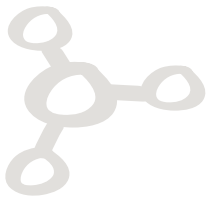
Preparation:

Place interesting objects for observation in lunch bags to keep hidden from student view.

Procedure:

First Session

1. Tell students as they will be investigating exhibits at the New York Hall of Science and will choose one exhibit to explain to the class when they return. (students can work in groups or individually)
2. Tell students they are going to do an activity to practice their observation and describing skills.
3. Distribute materials to student pairs.
4. Tell students that the person who is holding lunch bag will now describe the object inside to the other person without naming the object or describing what it is used for. Only descriptions of what the object looks like are allowed. The other student must guess what the object is.
5. Allow student pairs to complete activity and then switch lunch bags with another student pair. Each student pair should have a new object.
6. Repeat activity.





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7. Conclude activity by telling students they will need these same skills of careful observation and detailed describing to explain exhibits they investigate.
8. Conclude the session by leading a discussion about what students can do at the New York Hall of Science to help explain and record what they see. Ideas include:
 - sketching
 - writing
 - using exhibit pictures on this web site
 - photography
9. Distribute The On-Site Investigation Handout for use at the New York Hall of Science.
10. Go to the New York Hall of Science.

Second Session



1. Upon return to class from the trip, tell students they will spend time preparing to explain one of the exhibits they saw.
2. Here are some suggestions for student presentations:
 - Verbal explanation (with or without picture-good for ESL students)
 - Labeled diagram
 - Group or individual poster showing how an exhibit worked
 - Group or individual model using materials to represent exhibit (materials can be used to substitute and represent real materials from exhibit— ex. Clear plastic wrap simulates glass, cardboard tube becomes a rocket etc.)

Third Session (optional)

Use this time for students to make their class presentations if they made posters, drawings or models. Note: Your class may want to make their presentations to another class or younger students as well.



Science Court: Black Outs and the Power Grid

Description:

In this activity students will research and debate the question: What should be done to prevent major blackouts in the U.S.? Two points of view will be debated; work with the existing power grid or re-design the power grid.

Time: (4) 45 minute sessions

Materials Needed:

(per student team)

- Internet access or library
- Print outs of The Northeast Blackout of 2003
- Print outs of The Grid and How it Works
- Print outs of A Smarter Power Grid
- Print outs of A NERC Blackout Recommendations
- Index cards





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Procedure:

First Session

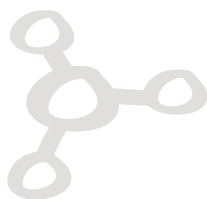
1. Tell students they will be participating in a mock court session debating the question: What should be done to prevent major blackouts in the U.S.? Two points of view will be debated; work with the existing power grid or re-design the power grid.
2. Tell students they will be divided into two groups to present both sides of the debate: Existing Grid and Re-Design Grid.
3. Tell students the case will be decided by the judge (teacher) or a jury (another class).
4. Divide the class into the Existing Grid Group and Re-Design Grid Group.
5. Hand out The Northeast Blackout of 2003 and The Grid and How it Works to all students.
6. Hand out NERC Blackout Recommendations print out to the students in the Existing Grid Group.
7. Hand out A Smarter Power Grid print out to the students in the Re-Design Grid Group.
8. Use the remaining time to let students read through the print outs and discuss them in their groups.

Second Session

1. Divide class into the two groups again.
2. Have students review the articles and highlight major points they want to use in their argument.
3. Conduct a preliminary hearing by having each group reveal one or two facts for their argument.
4. Tell students that they now have some idea about their opposition and are more likely to win their case if they have more facts than the other side.
5. Help students to see where they may need more research by asking the following questions:
 - Does your group have more facts or opinions? (opinions don't hold much weight in a debate)
 - Does your group have enough information to oppose the other side?
 - What arguments from the opposition do you need to do more research on?
6. Discuss research sources where students can further prepare for their case. (Library, internet)
7. Assign research for homework.
8. Tell students they will prepare their case in the next session.

Third Session

1. Have students divide into their groups and discuss their research findings.
2. Have student groups choose a 2-3 representatives to present their case in court.
3. Have student groups choose 2-3 writers who will make index cards for the representatives.
4. Tell students they will have 15 minutes to present their group's case.
5. Student groups spend the remainder of the time preparing their case for the court session.





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Fourth Session



1. Court is in session.
2. Set up the room so that representatives from each student group can present their case.
3. Allow each group 15 minutes to present their case.
4. Allow 10 minutes for the other class jury to deliberate on who presented their case the best.
5. If another class jury is not available spend 10 minutes discussing who presented their case the best with the entire class. The teacher acts as judge and makes a final ruling.





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The Northeast Blackout of 2003-Print Out

On August 14, 2003, large portions of the Midwest, Northeast United States and Ontario, Canada, experienced an electric power blackout. The outage affected an area with an estimated 50 million people in the states of Ohio, Michigan, Pennsylvania, New York, Vermont, Massachusetts, Connecticut, New Jersey and the Canadian province of Ontario. The blackout began a few minutes after 4:00 p.m. Eastern Daylight Time, and power was not restored for 4 days in some parts of the United States. Parts of Ontario suffered rolling blackouts for more than a week before full power was restored.

Ohio- August 14, 2003

12:15 EDT-A system monitoring tool was made ineffective by inaccurate human data input.

13:31 EDT- Eastlake 5 generation unit shut down automatically.

14:14 EDT- The alarm and logging system in the control room failed.

15:05 EDT-Some transmission lines began tripping out because the lines were contacting overgrown trees.

15:46 EDT- The system was in jeopardy, the only way that the blackout might have been averted would have been to drop at least 1,500 MW of load around Cleveland and Akron. No such effort was made.

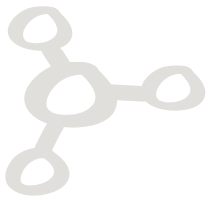
15:46 EDT- The loss of some of key lines in northern Ohio caused its underlying network of lines to begin to fail.

16:06 EDT- The high voltage Sammis-Star line locks-out and shuts down.

The Sammis-Star line failure was the event that triggered a cascade of interruptions on the high voltage system, causing electrical fluctuations and facility shut downs. Within seven minutes the blackout rippled from the Cleveland-Akron area across much of the northeast United States and Canada. By 16:13 EDT, more than 508 generating units at 265 power plants had been lost, and tens of millions of people in the United States and Canada were without electric power.

Source:

<http://www.nerc.com/~filez/blackout.html>



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The Grid and How it Works-Print out

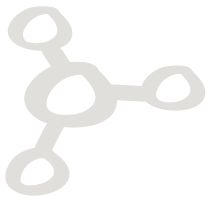
The North American electricity system is one of the great engineering achievements of the past 100 years. This electricity infrastructure has more than 200,000 miles of transmission lines operating at 230,000 volts and greater, 950,000 megawatts of generating capability, and nearly 3,500 utility organizations serving well over 100 million customers and 283 million people.

Electricity is produced at lower voltages (10,000 to 25,000 volts) at generators from various fuel sources, such as nuclear, coal, oil, natural gas, hydro power, geothermal, photovoltaic, etc. Some generators are owned by the same electric utilities that serve the end-use customer; some are owned by independent power producers (IPPs); and others are owned by customers themselves—particularly large industrial customers. Electricity from generators is “stepped up” to higher voltages for transportation in bulk over transmission lines. Operating the transmission lines at high voltage (i.e., 230,000 to 765,000 volts) reduces the losses of electricity from conductor heating and allows power to be shipped economically over long distances. Transmission lines are interconnected at switching stations and substations to form a network of lines and stations called a power “grid.” Electricity flows through the interconnected network of transmission lines from the generators to the loads in accordance with the laws of physics—along “paths of least resistance,” in much the same way that water flows through a network of canals. When the power arrives near a load center, it is “stepped down” to lower voltages for distribution to customers.

While the power system in North America is commonly referred to as “the grid,” there are actually three distinct power grids or “interconnections” The Eastern Interconnection includes the eastern two-thirds of the continental United States and Canada from Saskatchewan east to the Maritime Provinces. The Western Interconnection includes the western third of the continental United States (excluding Alaska), the Canadian provinces of Alberta and British Columbia, and a portion of Baja California Norte, Mexico. The third interconnection comprises most of the state of Texas. The three interconnections are electrically independent from each other except for a few small direct current (DC) ties that link them.

Source:

<http://www.nerc.com/~filez/blackout.html>





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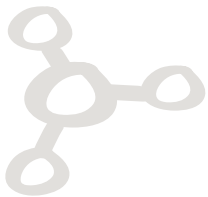
NERC Blackout Recommendations-Print Out

The North American Electric Reliability Council (NERC) and the electric industry have taken significant steps to improve the reliability of the bulk electric system. Both NERC and the US-Canada Power System Outage Task Force examined the causes of the blackout and made extensive recommendations on a wide range of actions needed to reduce the possibility of such an outage occurring in the future. The most significant actions taken to date include correcting the direct causes of the blackout, conducting extensive readiness reviews of all major system operators, and substantially revising existing reliability standards. We are developing new reliability standards to ensure that the reliability “rules of the road” are understood and followed by all individuals whose operations affect the reliability of the bulk electric system. Although many important initiatives have been completed or are well under way, some will take years to implement. Taken as a whole, these extensive and cooperative efforts will go a long way to reduce the risk of another major outage on the North American bulk electric system.

Source:

08/11/04

Status Report on NERC Implementation of August 14, 2003, Blackout Recommendations
<http://www.nerc.com/~filez/blackout.html>

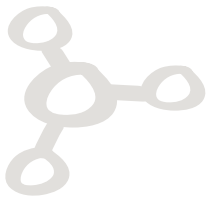


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A Smarter Power Grid-Print Out



The U.S. power grid has been called the largest machine ever built by man. In fact it's really three loosely interconnected grids: one in Texas, and two more splitting the bulk of the country roughly along the Continental divide). These systems are far from orderly; each grid is composed of a tangle of transmission lines operated by a hodgepodge of owners, from sprawling federal power authorities to regulated utilities to market-savvy conglomerates. An equally variable set of state, regional and federal regulators governs aspects of this mosaic, deciding how much power can enter the grids and flow over each set of lines.



Despite its structural and regulatory complexity, though, the power grid operates on a startlingly simple basis: electricity flows from where it's produced to its destination through the path of least resistance. That worked fine in the days when monolithic electrical monopolies strategically sited their power plants on the grid, with the path of least resistance leading straight to their own customers and no one else's. But those days are long gone. Deregulation of the electrical industry in the 1990s opened the grid to anyone and everyone who had electricity to sell. Dozens of brokers building new power plants and old utility giants with a fresh entrepreneurial bent now want to supply whoever offered the highest price for their power, wherever he or she may be. And that's where the physics of the existing grid comes up dangerously short.

The changing nature of the electrical industry dictates complex crisscrossing flows of electricity and the need to send more and more power over long distances. "We're trying to use [the electric grid] for a lot of longer-distance power transfers, and it's just stretching to the limit," warns Thomas Overbye, a power systems expert at the University of Illinois at Urbana-Champaign. Indeed, there already have been signs of troubles. In the blistering summer of 1996, the western U.S. electric grid snapped twice as swollen lines feeding hydroelectric power from the Pacific Northwest to California overloaded and shorted out. The result? Blackouts in 11 western states, Alberta, British Columbia, and Baja California. To avoid a repeat of that crisis, grid operators in California must restrict flows to the state, a fact that is greatly exacerbating its ongoing power crunch.



If today's situation sounds to you like a recipe for even worse power meltdowns, get your candles ready-because while hundreds of planned new power plants around the country will increase the amount of available electricity, utilities are investing next to nothing in additional transmission lines to get the juice to where it's needed. It used to be that the big utilities owned and maintained their share of the grid. But deregulation has orphaned the transmission business, uncoupling the lines that deliver electricity from revenue-producing power plants. And owning transmission lines is a business few want any part of. If you think building new power plants is unpopular, try running high-power transmission lines through someone's backyard. (Do electromagnetic radiation and contentious town-hall meetings come to mind?) Just 13,500 kilometers of high-voltage transmission additions are planned throughout North America over the next decade-a 4.2 percent increase-of which only a fraction are likely to get built. Meanwhile, the U.S. Department of Energy estimates that generating capacity in the United States alone will grow more than 20 percent over that period.



If you can't build enough new transmission lines to keep pace with the growing power demand, it becomes imperative to build a more efficient way to direct electricity over long distances. In the same way that telecommunications companies have created a complex yet seamless network controlled by automated electronic switches that zap phone calls and data around the world, the engineering giants that build transmission systems are attempting to reenergize the grid electronically.

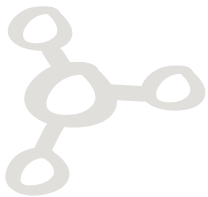


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Because high-power transmission is so unstable, operators must often limit a line's load to as little as 60 percent of its ultimate thermal capacity (the point at which the wire overheats, sags into trees or onto the ground, and shorts out). Power electronics is beginning to reclaim this lost capacity using programmable processors that can patch over a surge or sag within a small fraction of a second. That's a big advance over conventional grid controls, which can be as slow as manually adjusting a transformer or as unsophisticated as automatic breakers that sense a disturbance and "trip" a transmission cable off line, sending a tsunami of power surging through neighboring circuits.

The grand vision, of course, is to electronically tame the nation's vast power network. Unlike isolated devices that regulate a few lines each, integrated network controls could synchronously tweak all of a system's electronics to optimize flow over the entire grid. Stahlkopf of the Electric Power Research Institute estimates that integrated control could boost the overall transmission capacity of existing infrastructure by 30 to 40 percent. Stahlkopf figures this leap forward is at least 10 years off, but he says utilities are already beginning to take an important step-wide-area telemetry providing operators with a real-time picture of how much power is flowing over their lines and from where.

Source: Peter Fairley, A Smarter Power Grid, *Technology Review*, July/August 2001



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Laboratory Activities

Laboratory Activities are designed for the classroom and generally require simple materials. These activities can be done before or after a visit to the New York Hall of Science. To help students use higher-level thinking and generate questions, facilitate discussion with these types of questions:

- What do you notice here?
- Tell me about this.
- What do you see?
- Why do you suppose this happens?
- What can you conclude from the evidence?

Make An Ant Farm!

Description:

Students make an ant farm for live ants using simple materials. Tunnel formations are observed.

Time:

(1) 45 minute session

Observation and maintenance over time

Materials Needed:

(per student team)

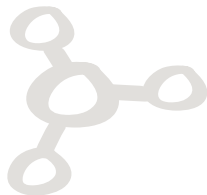
- large jar (able to fit soda can inside)
- dirt
- unopened soda can
- piece of sponge
- cloth
- rubber band
- black construction paper (enough to wrap around jar)
- tape
- ants-These can be ordered from a science catalog or collected from outside. Ants from Carolina Biological Supply Company will cost between 6-9\$, and you receive 30 worker ants (they can't sell queen ants). If you decide to collect ants from outside, keep in mind that the ants need to come from the same colony or else they will kill each other.

Preparation:

- Gather enough dirt to fill the jars half way.
- Provide a scoop and easy student access to dirt.
- If you bought ants from a science catalogue read instructions on how to distribute

Procedure:

1. Divide class into student teams according to available materials.
2. Distribute materials. (except ants and dirt)
3. Have students put the soda can into the glass jar. (The soda can forces the ants to build tunnels near the outside of the jar where they can be seen.)
4. Have students fill the rest of the glass jar with dirt -do not pack the dirt too tightly but fill the entire jar.
5. Have students place a small piece of wet sponge on top of the soft drink can.
6. Now students are ready to add the ants. Do either of the following:



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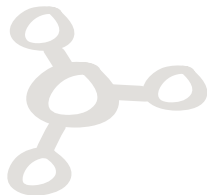
- Go on an ant hunt outside the classroom- remember ants need to come from the same colony or else they will kill each other
- Distribute ants bought from science catalogue

7. Once ants are in the jar, have students cover the lid with the cloth and a rubber band.
8. Have students tape the black paper over the outside of the jar. (ants will tunnel against the dark sides of the jar and it may take a week for the complex tunnels to really begin developing)

Ant Colony Maintenance

- Feed the ants by placing food scraps on top of the dirt (try sugar water, dry pet food, and pieces of fruit)
- Keep sponge moist
- Black paper can be removed for short periods to observe tunnels.

Adapted from "Entomological Society of America's seasonal lessons and activities"



Ant Farm Lab

Description:

Students make an ant farm for live ants using common construction materials. A structured investigation with lab reports is included.

Time:

(3) 45 minute sessions
Observation and maintenance over time

Materials Needed:

(per student team)

- 2 pieces of plexiglass (14"x12")
- roll of 3/8" adhesive weatherstripping
- Tube of acrylic-based bathroom caulking
- modeling clay for ant farm base and sealed top
- damp sand (2 cups per farm)
- damp cotton ball
- dry dog food or fruit pieces
- scissors
- ruler
- ants-These can be ordered from a science catalog or collected outside. Ants from Carolina Biological Supply Company will cost between 6-9\$, and you receive 30 worker ants (they can't sell queen ants). If you decide to collect ants from the outside, keep in mind that the ants need to come from the same colony or else they will kill each other.

Preparation:

- Provide a 2 cup scoop and damp sand for easy student access
- If you bought ants from a science catalogue read instructions on how to distribute

Procedure:

First Session

1. Divide class into student teams according to available materials.
2. Distribute materials. (except ants and damp sand)
3. Have students take one piece of plexiglass and remove any plastic coverings.

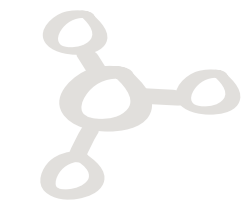


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4. Instruct students to stick adhesive weatherstripping 3/4" from the edge of the plexiglass on three sides.
5. Have students attach another strip of weatherstripping on top of the original so that it is now twice as thick.
6. Now have students remove the plastic coverings from the second piece of plexiglass.
7. Instruct students to attach the second piece of plexiglass to the first, so they have a weatherstripping sandwich that will contain the sand for the ants.
8. Now have students apply caulking around the three sides of the ant farm so that it is flush with the edges of the plexiglass.
9. Let it sit overnight.

Second Session



1. Have students carefully sift the sand between the two plexiglass sides until it is approximately 3/4 of the way filled. Do not pack the sand.
2. Have students use clay to create a sturdy base.
3. Now students are ready to add the ants. Do either of the following:
 - Go on an ant hunt outside the classroom- remember ants need to come from the same colony or else they will kill each other
 - Distribute ants bought from science catalogue
4. Have students place one damp cotton ball and one piece of food in the ant farm. (The cotton ball needs to be changed every other day depending on your climate.)
5. Have students use clay to seal the top of the ant farm.

Third Session



1. Tell students they are going to conduct a scientific investigation of the ants in the farm.
2. The class begins the investigation by brainstorming questions. Examples include:
 - Do ants walk in long lines following each other or do they move randomly?
 - Do ants prefer one type of food material over another?
 - Do certain materials deter ants?
3. Split the class into project teams and ask them to choose one question to investigate from the list of questions the class has generated. (It should be a question that they think that they can answer by using a scientific experiment.)
4. Instruct students to write out a detailed experimental design in their project teams. Their lab report can include the following criteria:
 - Title
 - Introduction
 - Investigation Question-Hypothesis
 - Methods/Procedures
 - Observations/Data Collection



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- Conclusions/Interpretations

5. Circulate the class and assist as needed.

Observation Over Time

1. Guide students in creation of tables and graphs.
2. Allow students time to analyze data.

Shortest Distance Challenge

Description:

Students take up the challenge to find the shortest distance between nine locations.

Time:

(1) hour session

Materials Needed:

- Nine heavy objects (that a string can be tied to)
- Large ball of string
- Measuring tape or stick (per student team)
- pencil
- blank paper

Preparation:

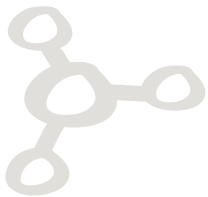
- Place the nine heavy objects around the room

Procedure:

1. Begin by presenting the challenge scenario to students:

There are nine random spots in the room that have a piece of rotting food leftover from a recent class party. Now suppose a pregnant fly is in the room and wants to lay a few hundred eggs at each food site. This fly is on its last wings, and wants to visit each site, lay eggs once and then return to the starting point in the shortest distance possible. Our challenge is to find the most efficient flight plan for the fly.

2. Point out the nine objects located around the room and tell students the objects represent the rotting food.
3. Instruct student teams to sketch the location of the objects on the room and try to figure out the most efficient flight plan for the fly.
4. After about 15-20 minutes, have students teams try out their flight plans by using the string to simulate the flight path.
5. Have students secure the string at each location.
6. When students have visited all nine locations and returned to the start, have students measure the length of the string that was used in the flight path.
7. The team that uses the least amount of string for the flight path wins the challenge.





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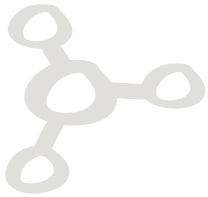
Book List

The Spider's Web

Tesar, Jenny. Spiders, Blackbrich Book, 1993.

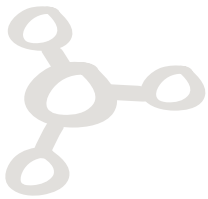
The Internet

Gay, Martin and Kathlyn Gay. The Information Superhighway, Twenty-First Century Books, 1996.



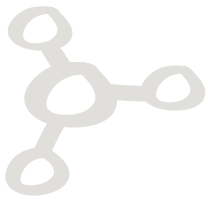


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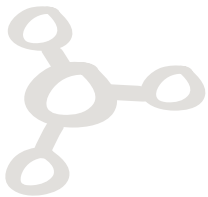


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