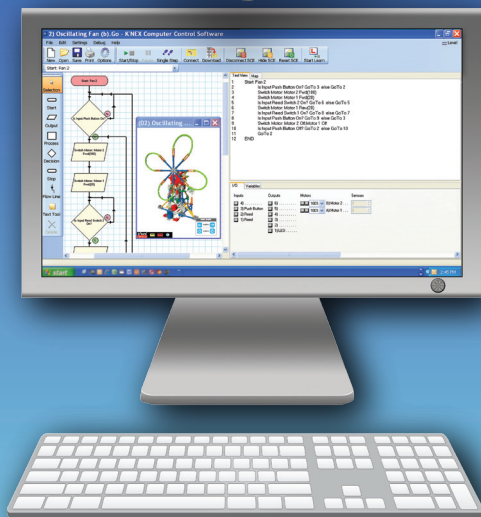


## K'NEX COMPUTER CONTROL<sup>™</sup>

### Teacher's Guide



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# K'NEX COMPUTER CONTROL™

## Teacher's Guide

**17901801-V1-10/11**

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**⚠ WARNING: CHOKING HAZARD – SMALL PARTS.** Not for children under 3 years.

**⚠ CAUTION - ELECTRIC TOY:**

Not recommended for children under 8 years of age. As with all electric products, precautions should be observed during handling and use to prevent electric shock.

The toy must only be used with the recommended transformer.

Disconnect transformer before cleaning any components.

The transformer is not a toy.

All components of this set must be regularly examined for damage. This includes the cord, plug, enclosure and other parts, and in the event of such damage, they must not be used until the damage has been repaired.

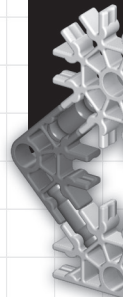
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# Introduction:

You and your students are about to embark on an awesome STEM (Science, Technology, Engineering and Mathematics) learning adventure with the K'NEX Education Computer Control Set. Students will build and write programs to control five dynamic K'NEX models. Once the models are constructed and the programs are written, students will progress through a series of meaningful and rigorous science, technology, engineering, and mathematics Learning Tasks and Challenge Activities designed to guide their learning and challenge them to use critical thinking and problem solving skills.

The set comes complete with the K'NEX Computer Control Interface that mediates and facilitates two-way communication between the computer, the model, and the devices that control its operation. Motors, push button switches, reed switches, a buzzer, and LEDs are included. The motors, buzzer, and LEDs are output devices which accept and react to commands through the interface, adding motion, sound, and light to the model. The push button switches and the reed switches provide data and control signals from the model to the computer to activate or deactivate portions of the student designed program. For example, the program may turn on a motor when the push button is pressed or to turn off a motor when the reed switch is activated by a magnet.

\* In addition to these great features, the K'NEX Education's Computer Control Software recreates the control experience for students; right on their computer screens. Computer simulations of the K'NEX models, or Simulated Control Environments (SCEs) excite student's interest and motivate them to learn. The software provides a flowchart based programming language that allows students to control the inputs and outputs of a simulation of the K'NEX model, on-screen. Students will sequence programming symbols in a flowchart format as they program the SCE to operate, allowing them the opportunity to practice and refine their programming skills before they design and write programs to operate the real K'NEX models.

## **To begin, have students open an SCE.**

- ✱ Open the K'NEX Computer Control Software.
- ✱ Click on 'Connect SCE.'
- ✱ A file dialogue box will appear listing all of the SCEs.
- ✱ Direct students to open the appropriate SCE.

The SCE simulation with an image of the selected K'NEX model will appear on the screen with a small tool bar. Describe each of the buttons on the tool bar.



Labels will appear as the students pass the cursor over the buttons. Ask students to click on the button with the upper case 'I' (Instruction). They will see the text that will guide their exploration.

This Teacher's Guide outlines a series of 5 comprehensive lessons that introduce students to computer control technology, writing programs to operate models, and rigorous content in science, technology, engineering, and mathematics.

The lessons are built around NSES Science Content Standards, ITEEA Standards for Technological Literacy, and NCTM Standards and Expectations for Mathematics. The objectives for each lesson highlight what students will learn and the processes they will use to meet those objectives. Science process skills, the engineering design process, the core concepts of technology, science inquiry, and the role of invention and innovation in technology will be emphasized throughout the lessons in this guide.

Students will build the K'NEX models from the full-color building instructions. Construction is not just matching colors with the instructions but an opportunity to watch a three-dimensional model come to life through the use of a two-dimensional design. As students build they will be constructing many systems that will work together in the final model. The construction phase of the lessons also requires students to connect electronic devices to their models and to the K'NEX Computer Control Interface. Following directions, troubleshooting, and attention to detail will enable students to produce models that will work the first time every time.

This set was designed to provide a themed approach to learning. The students will assume the role of teams of designers working for an Engineering Design firm. Over the course of the lessons students take on five major projects. The projects each include construction, design, redesign, programming, linear programming challenges, branched logic and programming challenges as well as determining the individual and combined costs of the projects, including wages for various classes of workers, cost of materials and profit. This is truly an integrated approach to STEM education in the classroom.

Before working with the construction phase of their activities, the students are encouraged to work with the on-screen versions of the K'NEX models or SCEs. These computer simulated models can complete many of the same functions as the actual K'NEX models and provide students with a chance to practice developing skills to control and program the actual models. Students will be directed to complete a series of Learning Tasks and Challenge Activities using both the on-screen and the student built models.

## Teacher Notes:

The K'NEX Education Computer Control Set provides exciting, dynamic materials and lessons that will help you guide and facilitate student learning. Using the materials provided in this set and the direction provided in this guide, you will be able to offer students a program of study that uses hands-on exploration in conjunction with an engaging inquiry-based approach to learning. As students work cooperatively they are encouraged to interact with each other as they build, program, investigate, discuss, and evaluate ideas.

The K'NEX Education Computer Control Set provides students with an excellent introduction to programming, control systems, programming displays (flow charts, etc.). It also allows them to program a series of five models to complete the actions they design and respond to input from the environment.

The onscreen programming capabilities of the K'NEX Computer Control Software are exciting in that the students can program moving images of the models they will soon build. The software has five established **Simulated Control Environments**

(**SECs**); one each for the five models in the set. As students program the model in the SCE to operate and the LEDs to light etc., they are dragging common computer flow chart symbols onto a grid and sequencing them to follow their train of thought. As they build the flow chart of the program, another section of the same computer window prepares another copy of the program in text format. When students have completed a program they can save the program and replay it at any time. These SCE activities will help students to learn aspects of linear and branched computer programming in a simulated environment before they move on the real thing with the real K'NEX models.

Once students move on to building actual models, they will be led through a series of Tasks and Challenge Activities. With the skills they develop through the use of the K'NEX Computer Control Set students will soon be designing, programming, and controlling models on their own without any direction or encouragement. It will become a challenge they are eager and willing to accept.

# Teacher's Guide:

This guide is intended as a resource for teachers and students as they tackle meaningful STEM content in the classroom. As students open the K'NEX Computer Control software they will use the SCEs to access a listing of their lessons including the Learning Tasks and Challenge Activities shown in this guide. The lessons each Include:

- ✳ **Student Objectives:** Objectives are provided for each of the six lessons included in the Teacher's Guide.
- ✳ **Requirements:** A list of the items that students are responsible for as they complete the activities outlined in the various lessons.
- ✳ **Context:** Introductions to each lesson that will pique student interest and establish the reason for the activity.
- ✳ **Construction:** Full-color building instructions to build the models and to wire the K'NEX Computer Control Interface.
- ✳ **Learning Tasks:** Investigations that are to be completed first using the SCE for each model and then with the models themselves. These Learning Tasks sharpen students' skills with the features of the K'NEX Computer Control Interface and programming so they will be successful with the Challenge Activities that follow.
- ✳ **Challenge Activities:** extended learning opportunities to include specific programming, science, engineering, math, and technology explorations. Additionally, the Challenges include cost of materials and billing activities that teach sound business skills and provide an opportunity for students to use spreadsheets if the programs are available.
- ✳ **Written copies of the students' lessons:** The lessons are divided into two levels of Learning Tasks and Challenge Activities. The science and mathematics activities in Level 1 are more appropriate for students in 3rd to 5th grade. Level 2 is intended for students in grades 6th through 8th. Level 2 includes both levels of Learning Tasks and Challenge Activities to support a wide range of student abilities in the same classroom.

The requirements, context, construction, learning tasks and challenge activities will also appear on the students' computer screens, allowing them to scroll through the text and complete the tasks and activities. You will find important Information and teacher notes shown in grey throughout the lessons. This information is not provided within the software and is intended to provide you, the teacher, with additional information to help you better guide the students and provide support.

Each time students write a new program for their SCE or model, they should record the locations where the various Input and Output devices are connected to the K'NEX Computer Control Interface. A reproducible copy of the K'NEXions chart shown below is also provided in reproducible form in the back of this guide. The K'NEXions Charts will make it easy for the students to record this information.

## K'NEX Computer Control

### K'NEXions Chart

Model \_\_\_\_\_

Inputs	Motors	Outputs
		6
		5
4		4
3		3
2	B	2
1	A	1

# The K'NEX Education Computer Control Set:

---

- ✱ **699 K'NEX Rods and Connectors** – These pieces provide sufficient materials to serve a group of 1 to 2 students working as a team.
- ✱ **K'NEX Computer Control Interface** – An intelligent interface box that receives signals from a computer program and routes those signals to operate the various output devices (motors, LEDs, Buzzers). The interface also relays information from input devices (reed switches, etc.) to the computer so a student's program can respond to those signals.
- ✱ **K'NEX Computer Control Software** – The software allows students to write programs by clicking and dragging programming symbols into the sequence they design to operate simulations of each of the five K'NEX models and the actual models themselves. The software also guides the investigation of fully-functioning K'NEX models through on-screen directions, Learning Tasks and Challenge Activities. The software has two instructional levels to support students with a range of abilities.
- ✱ **K'NEX Computer Control Electronic Output Devices** –
  - Two Motors
  - Three LEDs
  - One Buzzer
- ✱ **K'NEX Computer Control Electronic Input Devices** –
  - One Push Button Switch
  - Two Reed Switches
  - Four Magnets
- ✱ **Building instructions** – These full-color graphics allow students to easily construct the models included in this set and to expertly wire the models and the K'NEX Computer Control Interface.
- ✱ **Five Great Models** – The set will allow students to construct the following models one at a time.
  - Sliding Door
  - Oscillating Fan
  - Super Spinner Ride
  - Bascule Bridge
  - Elevator

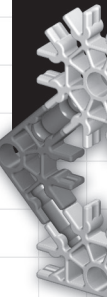
As with any classroom manipulative and especially this high tech control system, it is strongly suggested that you provide time for students to explore the use of the K'NEX Computer Control Interface, motors, LEDs, buzzer, and inputs. Many of the students in your classroom will be familiar with K'NEX Rods and Connectors, students are curious and will want to explore and investigate. Consider providing some time at the beginning of the Sliding Door lesson for students to do so.

When you first introduce K'NEX in the classroom, ask for a show of hands to identify which students have used K'NEX in other classrooms or at home. When you form groups for instruction, include an experienced K'NEX builder in each group. Also, assign groups carefully so that students of varying abilities are in each group. Research findings recommend that the teacher assign students to the work groups and not allow students to self select groups. Also, it is important to change group make-up from time to time.

## Student Journals:

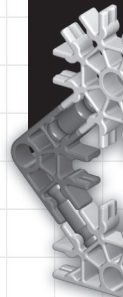
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Journaling is a critical component of a STEM program. Students need to keep records of all of their work and all of their ideas. Working scientists use lab notebooks or field notebooks and engineers use design journals to record their work. It is strongly suggested that the students maintain a STEM Journal throughout these 5 lessons to document their work. A loose-leaf format serves this purpose well. Students should include notes, drawings, conjectures and reflections in addition to copies of programs they write with each lesson. The journal will provide a comprehensive record of the growth of individual students and provide you with an excellent source for assessment data.



# ITEEA Standards Alignments with K'NEX Computer Control Lessons

ITEEA Standards for Technological Literacy <i>Students will develop an understanding of:</i>	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
<b>THE CHARACTERISTICS AND SCOPE OF TECHNOLOGY</b>						
<i>Grades 3 - 5</i>						
• Tools, materials, and skills are used to make things and carry out tasks.	✱	✱	✱	✱	✱	✱
<i>Grades 6 - 8</i>						
• New products and systems can be developed to solve problems or to help do things that could not be done without the help of technology.		✱	✱	✱	✱	✱
• Technology is closely linked to creativity, which has resulted in innovation.		✱	✱	✱	✱	✱
<b>THE CORE CONCEPTS OF TECHNOLOGY</b>						
<i>Grades 3 - 5</i>						
• Requirements are the limits to designing or making a product or system.		✱	✱	✱	✱	✱
<i>Grades 6 - 8</i>						
• Systems thinking involves considering how every part relates to others.	✱	✱	✱	✱	✱	✱
• Technological systems can be connected to one another.	✱	✱	✱	✱	✱	✱
• Different technologies involve different sets of processes.	✱	✱	✱	✱	✱	✱
<b>RELATIONSHIPS AMONG TECHNOLOGIES AND THE CONNECTIONS BETWEEN TECHNOLOGY AND OTHER FIELDS</b>						
<i>Grades 3 - 5</i>						
• Various relationships exist between technology and other fields of study.		✱	✱	✱	✱	✱
<i>Grades 6 - 8</i>						
• Knowledge gained from other fields of study has a direct effect on the development of technological products and systems.		✱	✱	✱	✱	✱
<b>THE CULTURAL, SOCIAL, ECONOMIC, AND POLITICAL EFFECTS OF TECHNOLOGY</b>						
<i>Grades 6 - 8</i>						
• The use of technology affects humans in various ways, including their safety, comfort, choices, and attitudes about technology's development and use.		✱	✱	✱	✱	✱
<b>THE ATTRIBUTES OF DESIGN</b>						
<i>Grades 3 - 5</i>						
• Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.		✱	✱	✱	✱	✱
<i>Grades 6 - 8</i>						
• Design is a creative planning process that leads to useful products and systems.		✱	✱	✱	✱	✱



ENGINEERING DESIGN					
<i>Grades 3 – 5</i>					
• When designing an object, it is important to be creative and consider all ideas.		☼	☼	☼	☼
• Models are used to communicate and test design ideas and processes.		☼	☼	☼	☼
<i>Grades 6 – 8</i>					
• Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.		☼	☼	☼	☼
APPLY DESIGN PROCESS					
<i>Grades 3 - 5</i>					
• Improve the design solutions.		☼	☼	☼	☼
<i>Grades 6 - 8</i>					
• Apply a design process to solve problems in and beyond the laboratory-classroom.		☼	☼	☼	☼
• Make a product or system and document the solution.		☼	☼	☼	☼
USE AND MAINTAIN TECHNOLOGICAL PRODUCTS AND SYSTEMS					
<i>Grades 3 - 5</i>					
• Use computers to access and organize information.		☼	☼	☼	☼
• Follow step-by-step directions to assemble a product.		☼	☼	☼	☼
<i>Grades 6 – 8</i>					
• Use computers and calculators in various applications.	☼	☼	☼	☼	☼
• Select and use energy and power technologies					
<i>Grades 6 – 8</i>					
• Energy can be used to do work, using many processes.		☼	☼	☼	☼
• Power systems are used to drive and provide propulsion to other technological products and systems.		☼	☼	☼	☼

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## NSES Standards Alignments with K'NEX Computer Control Lessons

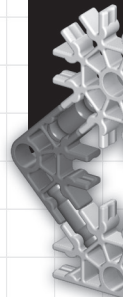
National Science Education Content Standards	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
<i>Students will develop an understanding of:</i>						
UNIFYING CONCEPTS AND PROCESSES						
• Systems, order, and organization	☼	☼	☼	☼	☼	☼
• Evidence, models, and explanation		☼	☼	☼	☼	☼
• Measurement		☼	☼	☼	☼	☼
• Form and function	☼	☼	☼	☼	☼	☼

<b>A. SCIENCE AS INQUIRY</b>						
• Abilities necessary to do scientific inquiry	✱	✱	✱	✱	✱	✱
• Understandings about scientific inquiry	✱	✱	✱	✱	✱	✱
<b>B. PHYSICAL SCIENCE</b>						
<i>Grades K-4</i>						
• Position and motion of objects	✱	✱	✱	✱	✱	✱
<i>Grades 5 - 8</i>						
• Motions and Forces		✱	✱	✱	✱	✱
• Transfer of energy		✱	✱	✱	✱	✱
<b>E. SCIENCE AND TECHNOLOGY</b>						
• Abilities of technological design		✱	✱	✱	✱	✱
• Understandings about science and technology		✱	✱	✱	✱	✱
<b>G. HISTORY AND NATURE OF SCIENCE</b>						
• Understanding of science as a human endeavor		✱	✱	✱	✱	✱
• Understanding the Nature of Science		✱	✱	✱	✱	✱

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## NCTM Standards Alignments with K'NEX Computer Control Lessons

<b>National Council of Teachers of Mathematics Standards and Expectations Grades 3 - 8</b> <i>Students will develop an understanding of:</i>	<b>Lesson 1</b>	<b>Lesson 2</b>	<b>Lesson 3</b>	<b>Lesson 4</b>	<b>Lesson 5</b>	<b>Lesson 6</b>
<b>NUMBERS AND OPERATIONS</b>						
• Understand numbers, ways of representing numbers, relationships among numbers, and number systems.		✱	✱	✱	✱	✱
<i>Grades 6 - 8</i>						
• Work flexibly with fractions, decimals, and percents to solve problems.		✱	✱	✱	✱	✱
• Understand and use ratios and proportions to represent quantitative relationships.		✱	✱	✱	✱	✱
• Understand meanings of operations and how they relate to one another.		✱	✱	✱	✱	✱
<i>Grades 3 - 5</i>						
• Understand various meanings of multiplication and division.		✱	✱	✱	✱	✱
• Understand the effects of multiplying and dividing whole numbers.		✱	✱	✱	✱	✱
• Compute fluently and make reasonable estimates.		✱	✱	✱	✱	✱



<i>Grade 3 - 5</i>						
• Develop fluency in adding, subtracting, multiplying and dividing whole numbers.		☼	☼	☼	☼	☼
• Select appropriate methods and tools for computing with whole numbers from among mental computation, estimation, calculators, and paper and pencil according to the context and nature of the computation and use the selected method or tools..		☼	☼	☼	☼	☼
<i>Grades 6 - 8</i>						
• Select appropriate methods and tools for computing with fractions and decimals for among mental computation, estimation, calculators or computers, and paper and pencil, depending on the situation, and apply the selected methods.		☼	☼	☼	☼	☼
<b>ALGEBRA</b>						
• Analyze change in various contexts.		☼	☼	☼	☼	☼
<b>MEASUREMENT</b>						
• Understand measurable attributes of objects and the units.		☼	☼	☼	☼	☼
• Apply appropriate techniques, tools, and formulas to determine measurements.			☼	☼	☼	☼
<i>Grades 6 - 8</i>						
– Solve simple problems involving rates and derived measurements for such attributes as velocity and density.			☼	☼		
<b>DATA ANALYSIS AND PROBABILITY</b>						
• Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.			☼	☼	☼	☼
<i>Grades 3 - 5</i>						
– Collect data using observation, surveys, and experiments.			☼	☼	☼	☼
– Represent data using tables and graphs such as line plots, bar graphs, and line graphs.			☼	☼	☼	☼
• Select and use appropriate statistical methods to analyze data.			☼	☼		☼
• Develop and evaluate inferences and predictions that are based on data.			☼	☼		☼
• Understand and apply basic concepts of probability.			☼	☼		☼
<b>PROCESS</b>						
• Problem Solving						
– Solve problems that arise in mathematics and in other contexts.			☼	☼	☼	☼
• Communication						
– Organize and consolidate their mathematical thinking through communication.			☼	☼	☼	☼
– Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.			☼	☼	☼	☼
• Connections						
– Recognize and apply mathematics in contexts outside of mathematics.			☼	☼	☼	☼

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## Objectives:

Students will demonstrate the ability to:

- ✓ Use K'NEX Computer Control software to sequence symbols to program a model of a K'NEX sliding door in a Simulated Control Environment (SCE).  
*(Science and Technology)*
- ✓ Program an actual K'NEX Sliding Door model to complete a series of tasks.  
*(Science and Technology)*
- ✓ Redesign a K'NEX Sliding Door model to produce a double-door system.  
*(Technology and Engineering)*
- ✓ Investigate and report on the gear and cam systems that operate the sliding door system.  
*(Science, Technology, and Engineering)*
- ✓ Solve problems that require addition and multiplication skills, data organization, and data presentation skills.  
*(Mathematics)*

## Context:

Your team is part of a larger company that researches, explores, plans, designs, constructs, and tests machinery and large mechanical systems. Your specific design team has been selected to complete five projects for the company. These five projects include:

- Sliding Door system for a super market chain
- Oscillating Fan for a small manufacturing company
- Super Spinner Ride for an amusement park
- Bascule Bridge that will control both river and roadway traffic
- Elevator system to serve a new Senior Center

## Requirements:

For this activity you are required to:

1. Make daily entries in your STEM Journal.  
*(Teacher Note: Help students to realize the importance of keeping records and journaling. Inform students of the materials they must include in their STEM Journals.)*
2. List the K'NEXions Chart for all of the Learning Tasks and Challenge Activities your team completes. This chart will be provided by your teacher.  
*(Teacher Note: A reproducible template page of K'NEXions Charts is included in this guide.)*
3. List and describe the steps in your programs. Keep a record of changes you made to programs as you improved them.  
*(Teacher Note: Students should list and describe their programs in their STEM Journals. If students have the ability to print their programs the copies can be place in their STEM Journals.)*
4. Include all calculations, charts, and graphs you prepare in your STEM Journal.
5. Name and save all of the programs that you write during this series of projects.  
*(Teacher Note: Remind students to select program names that are descriptive of the actions they direct and to include the lesson number they are associated with.)*

### **Good luck!**

Your first project is the construction, installation, and programming of a sliding door system for the entrance to a super market. It is important that the door operate safely and that it allows store customers plenty of time to enter and exit the store.

## Construction:

Use the instructions to build the K'NEX Sliding Door model.

*(Technology and Engineering)*

Ensure that all of the electronic components have been connected to the K'NEX Computer Control Interface before you begin work.

*(Teacher Note: The K'NEXions Chart below outlines the placement of the push button, reed switches, motor, and buzzer for the Learning Tasks in this lesson. The students will find this information in graphic form in the Building Instructions.)*

## K'NEXions Chart

K'NEX Sliding Door

Inputs	Motors	Outputs
		6
		5
4		4
3 Push Button		3
2 Open Door Reed Switch	B	2
1 Close Door Reed Switch	A Motor	1 Buzzer

## Learning Tasks:

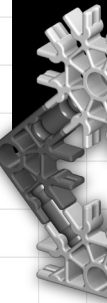
Complete these learning tasks using both the K'NEX Sliding Door SCE on the computer, the K'NEX model and K'NEX Interface.

*(Teacher Note: Encourage students to complete these learning tasks using the K'NEX Sliding Door SCE before they program the computer to operate the model with the K'NEX Interface.)*

Program the Sliding Door model so that it will operate automatically and allow the safe entry and exit of supermarket visitors.

This model contains two (2) reed switches (Door Open and Door Closed) which are normally in the **off** position. When a magnet is in close proximity to the switch, it will change to the **on** position. Write programs to check these switches to see if they are **on** or **off**. If the magnets and reed switches are placed as shown in the sliding door instructions, the reed switches will allow you to program the door to open and close completely.

- \* Write a program using the motor and reed switches to open and close the door. Use time delays to keep the door open long enough for visitors to enter or leave the store. Ensure your program loops so that the door is constantly in operation.  
*(Science and Technology)*
- \* Edit your program to add a buzzer sound when the door is about to close.  
*(Science and Technology)*
- \* Edit your program again so that the door opens and closes and the buzzer sounds when the push button is pressed.  
*(Science and Technology)*



## Challenge Activities:

As you move through the Challenge Activities listed below, you may have to change the location of some of the components or add additional components to the K'NEX Computer Control Interface. Part of the learning process is understanding when, where and how to make those changes.

1. \* Gears are found on the K'NEX Sliding Door model. They are wheel and axle simple machines that are used to make work easier. Some simple machines make work easier by:

- multiplying force,
- or by multiplying the distance something moves or its speed,
- and/or by changing the direction of force.

Check resources provided by your teacher or on the Internet to investigate gears further. Explain how the gears on the K'NEX Sliding Door make work easier in your STEM Journal. *(Science and Technology)*

2. \*\* Compute the gear ratio of the Sliding Door system. Identify the cam system on the model and describe the purpose of the cam. You may use outside resources to assist with this challenge. *(Science, Technology, and Mathematics)*

3. \* Refer to the building instructions for the K'NEX Sliding Door to complete the Cost per Piece Chart provided by your teacher. Determine the cost of the materials that are used to build the K'NEX Sliding Door.

- a. Make a data chart for this activity in your STEM Journal and include all of your calculations
- b. Place your answer on the board in the spot indicated by your teacher. *(Teacher Note: Set aside space on the white board or chalk board for each team to list their cost of materials so that the costs are visible to the entire class.)*
- c. How do your results compare with other groups who have completed the challenge? If answers vary, devise and implement a plan to check your work. *(Teacher Note: Provide time for the teams to compare their answers and to correct any differences. The Cost Per Piece Chart has been provided in an editable format allowing you to assign costs to the K'NEX pieces that are appropriate for the students you are working with. Use the same costs for all 5 lessons. This is an excellent project to complete with spreadsheet software if students have experience with spreadsheets. Students can design*

*data charts, enter formulas, and compute both the cost per each type of piece and the total cost of the pieces used in the project. Students will be computing similar information for other models. If the students have a spreadsheet already developed, they can easily add data for a new model to complete their work quickly and easily while taking advantage of technology.) (Science, Technology, and Mathematics)*

4. \*\* Prepare a bill for the cost of the project that will be given to the supermarket owners.

**First**, determine the cost of the materials that are used to build the sliding door system.

**Second**, include the cost of labor required to install the new sliding door. The door project will require that three employees work for 8 hours each on the actual removal of the old door and installation of the new door. Two of the employees make \$35.00 per hour each and the other employee makes \$25.00 per hour.

**Third**, include the cost of labor required to develop the software program that will operate the door. One programmer will work for 6 hours to program the door to operate efficiently and safely. The programmer makes \$125.00 per hour.

**Fourth**, add up all of the costs associated with the project and include a profit for your company that is 35% higher than the total of the other three costs. Prepare a bill for the project that includes all of the costs with 35% added to each of the categories. (For example, if the cost of materials is \$2,500.00 please add \$875.00 to represent the profit and report the cost of materials on the bill as \$3,375.00.) *(Teacher Note: This is an excellent opportunity for students to design a name and logo for their company. With those in hand, the students can prepare an official invoice to submit to their customer.) (Technology, Engineering, and Mathematics)*

5. \*\* Redesign and rebuild the model to be a double-door system to improve the flow of people entering and leaving the super market. Use appropriate inputs, motors, and outputs as you program the doors to operate in a synchronized pattern. *(Technology and Engineering)*

# Lesson 2

# Oscillating Fan

## Objectives:

Students will demonstrate the ability to:

- ✓ Research fans and fan technology in order to answer essential questions which will focus the research.  
*(Technology and Engineering)*
- ✓ Program a model and an SCE to respond to push button and reed switch inputs.  
*(Science and Technology)*
- ✓ Solve problems that involve rate and degree computations.  
*(Science and Mathematics)*
- ✓ Redesign the blades of the K'NEX Oscillating Fan to meet prescribed criteria.  
*(Technology and Engineering)*
- ✓ Change the gearing of the fan and analyze the impact of that change on the speed of the fan.  
*(Science, Technology, Engineering, and Mathematics)*

## Context:

Your team is now ready to take on your second project. A small manufacturing company has requested that you design an operating model of an oscillating fan that they can mass produce in time for the warm summer months. They would like the fan to operate at several speeds and to sweep from side to side as it blows cool air across a room.



**Good Luck!**

## Requirements:

For this activity you are required to:

1. Make daily entries in your STEM Journal.  
*(Teacher Note: Help students to realize the importance of keeping records and journaling. Inform students of the materials they must include in their STEM Journals.)*
2. List the K'NEXions Chart for all of the Learning Tasks and Challenge Activities your team completes. This chart will be provided by your teacher.  
*(Teacher Note: A reproducible template page of K'NEXions Charts is included in this guide.)*
3. List and describe the steps in your programs. Keep a record of changes you made to programs as you improved them.

*(Teacher Note: Students should list and describe their programs in their STEM Journals. If students have the ability to print their programs the copies can be placed in their STEM Journals.)*

4. Include all calculations, charts, and graphs you prepare in your STEM Journal.
5. Name and save all of the programs that you write during this series of projects.  
*(Teacher Note: Remind students to select program names that are descriptive of the actions they direct and to include the lesson number they are associated with.)*

## Construction:

Use the instructions to build the K'NEX Oscillating Fan model.

*(Technology and Engineering)*

Ensure that all of the electronic components have been connected to the K'NEX Interface before you begin work.

*(Teacher Note: The K'NEXions Chart outlines the placement of the LED, motors, push button, and reed switches for the Learning Tasks in this lesson. The students will find this information in graphic form in the Building Instructions.)*

### K'NEXions Chart

K'NEX Oscillating Fan

Inputs	Motors	Outputs
		6
		5
4		4
3 Push Button		3
2 Reed Switch # 2	B - Motor 2	2
1 Reed Switch # 1	A - Motor 1	1 LED

## Learning Tasks:

Complete these learning tasks using both the K'NEX Oscillating Fan SCE on the computer, the K'NEX model, and the K'NEX Interface.

*(Teacher Note: Encourage students to complete these learning tasks using the K'NEX Oscillating Fan SCE before they program the computer to operate the model with the K'NEX Computer Control Interface.)*

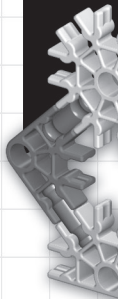
Program the Oscillating Fan model so that it will operate automatically to cool a room and keep people comfortable.

1. \* Write a program that makes the model oscillate (slow the oscillation motor to 20% power) as the blades spin when the push button is pressed.  
*(Science and Technology)*
2. \* Edit the program to stop the fan when the push button is pressed a second time. Include a loop in the program so that the fan can be turned on and off over and over again.  
*(Science and Technology)*
3. \* Edit the program so the LED shines green while the fan is spinning.  
*(Science and Technology)*

## Challenge Activities:

As you move through the Challenge Activities listed below, you may have to change the location of some of the components or add additional components to the K'NEX Interface. Part of the learning process is understanding when, where and how to make those changes.

1. \* Complete some research related to fans before continuing with the project. Use the following questions to guide your research and report all of your findings in your STEM Journal.
  - a. What is the purpose of a fan?
  - b. What are the different parts of a fan?
  - c. What are some of the different types of fans?
  - d. Why do you feel cool when a fan blows air over your skin?  
*(Teacher Note: Student performance on this Challenge Activity will be partially dependent on the grade and ability level of your students. Assess students accordingly.) (Science, Technology, and Engineering)*
2. \* Determine the speed of the K'NEX Oscillating Fan's blades in revolutions per minute (rpm). In other words, how many times do the blades spin in one minute?  
*(Science and Mathematics)*
3. \*\* Determine the average number of times the blades turn in one minute. Express this number as a speed with proper units. Run four trials as you collect your data. Present your data in a table and calculate the average speed of the fan blades.  
*(Science and Mathematics)*
4. \*\* Redesign the blades to move air as they spin. Cover the blades of the fan using paper and tape. Run the fan to see if you can feel air moving in front of the blades or behind the blades. If not, redesign the blades so that a breeze is produced in front of the blades as the fan runs. Experiment to see if further design changes will produce a stronger breeze.  
*(Science, Technology, Engineering)*
5. \*\* Change the gear ratio of the model and report the effect on the operation of the fan. Determine the gear ratio of the gear system on the fan. Switch the red and blue gears on the model. Does the fan operate differently when you run it after the blades have been changed? Describe the difference in operation. Determine the speed of the blades with the new gear configuration (four trials and a computed average). Is the fan now geared up or geared down? Support your answer with data from the experiment



you just completed and your findings in Challenge Activity number three (3) above. *(Science, Technology, Engineering and Mathematics)*

6. \*\* Research fan blades and the science behind their operation. Produce a short multimedia presentation that outlines your research, your findings and photos of the various blades and blade configurations you found. Present your work to the entire class. *(Science, Technology, and Engineering)*
7. \* Refer to the building instructions for the K'NEX Oscillating Fan and the Cost per Piece Chart provided by your teacher. Determine the cost of the materials that are used to build the K'NEX Oscillating Fan.
  - a. Make a data chart for this activity in your STEM Journal and include all of your calculations
  - b. Place your answer on the board in the spot indicated by your teacher. *(Teacher Note: Set aside space on the white board or chalk board for each team to list their cost of materials so that the costs are visible to the entire class.)*
  - c. How do your results compare with other groups who have completed the challenge? If answers vary, devise and implement a plan to check your work. *(Teacher Note: Provide time for the teams to compare their answers and to correct any differences. The Cost Per Piece Chart has been provided in an editable format allowing you to assign costs to the K'NEX pieces that are appropriate for the students you are working with. Use the same costs for all 5 lessons. This is an excellent project to complete with spreadsheet software if students have experience with spreadsheets. Students can design data charts, enter formulas, and compute both the cost per each type of piece and the total cost of the pieces used in the project. If the students designed a spreadsheet to compute the cost of materials in Lesson 2 they should be able to add a column to that spreadsheet to compute the material costs for the K'NEX Oscillating Fan.) (Science, Technology, and Mathematics)*

8. \*\* Prepare a bill for the cost of the project that will be given to the manufacturing company owners.

**First**, determine the cost of the materials that are used to build the oscillating fan system. You found this information for the Sliding Door in the previous challenge.

**Second**, include the cost of labor required to design and build the K'NEX Oscillating Fan. The fan project will require that two employees work for 24 hours each on the actual design of the fan. These designers each make \$150 per hour. Two builders will construct the fan in three hours. The builders each make \$28.00 per hour.

**Third**, include the cost of labor required to develop the software program that will operate the fan. One programmer will work for 10 hours to program the fan to operate efficiently and safely. The programmer makes \$125.00 per hour.

**Fourth**, add up all of the costs associated with the project and include a profit for your company that is 35% higher than the total of the other four costs. Prepare a bill for the project that includes all of the costs with 35% added to each of the categories.

*(Teacher Note: This is an excellent opportunity for students to design a name and logo for their company. With those in hand, the students can prepare an official invoice to submit to their customer.) (Technology, Engineering, and Mathematics)*



## Objectives:

The students will demonstrate the ability to:

- ✓ Solve simulated real-world problems with whole numbers and percents. (Mathematics)
- ✓ Program a model to operate two forms of motion in synchronization with one another using sub-procedures. (Science and Technology)
- ✓ Compare and contrast two gear systems found in a single model. (Science, Technology, Engineering, and Mathematics)
- ✓ Collect measurements, organize data, and compute averages of model speeds. (Science and Mathematics)
- ✓ Use computational skills to produce an invoice that includes cost of materials, wages, and profits. (Technology, Engineering, and Mathematics)

## Context:

Your team is now ready to take on your third project. A large amusement park that is located nearby is purchasing a giant spinning ride that lifts high in the air as the riders are held in place by centripetal forces. The ride is to be computer controlled to make the ride safer and more consistent in providing riders with an exciting experience.

**Good Luck!**

## Requirements:

For this activity you are required to:

1. Make daily entries in your STEM Journal. (Teacher Note: Help students to realize the importance of keeping records and journaling. Inform students of the materials they must include in their STEM Journals.)
2. List the K'NEXions Chart for all of the Learning Tasks and Challenge Activities your team completes. (Teacher Note: A reproducible template page of K'NEXions Charts is included in this guide.)
3. List and describe the steps in your programs. Keep a record of changes you made to programs as you improved them. (Teacher Note: Students should list and describe their programs in their STEM Journals. If students have the ability to print their programs the copies can be placed in their STEM Journals.)
4. Include all calculations, charts, and graphs you prepare in your STEM Journal.
5. Name and save all of the programs that you write during this series of projects. (Teacher Note: Remind students to select program names that are descriptive of the actions they direct and to include the lesson number they are associated with.)



## Construction:

Use the instructions to build the K'NEX Super Spinner Ride.

*(Technology and Engineering)*

Ensure that all of the electronic components have been connected to the K'NEX Interface before you begin work.

*(Teacher Note: The K'NEXions Chart below outlines the placement of the LEDs, motors, push button, and reed switches for the Learning Tasks in this lesson. The students will find this information in graphic form in the Building Instructions.)*

**K'NEXions Chart**  
Super Spinner Ride

Inputs	Motors	Outputs
		6
		5
4		4
3 Push Button		3 LED
2 Reed Switch 2	B - Motor 2	2 LED
1 Reed Switch 1	A - Motor 1	1 LED

## Learning Tasks:

Complete these learning tasks using both the K'NEX Super Spinner Ride SCE on the computer, the K'NEX model and the K'NEX Interface.

*(Teacher Note: Encourage students to complete these learning tasks using the K'NEX Super Spinner Ride SCE before they program the computer to operate the model with the K'NEX Computer Control Interface.)*

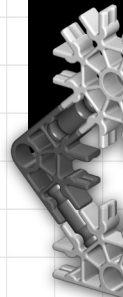
Program the Super Spinner Ride model so that it will operate automatically to provide riders with an exciting ride experience.

1. \* Write a program that will include a series of sub-procedures to operate the various systems that make up the Super Spinner Ride. Your team's task will be to fashion the sub-procedures into a sequence that will operate the ride. The following list outlines the various sub-procedures that will need to be written for this task. Test each of the sub-procedures as they are written to ensure they operate just as your team has planned.
  - a. You will need to write a program and label it 'UP.' This is the sub-procedure that will raise the arm that carries the passenger cars of the ride. The program should switch on motor #1 in the forward direction that will raise the arm.
  - b. The second sub-procedure will lower the arm of the ride and should be named 'DOWN'. The sub-procedure should switch on motor #1 in the reverse direction that will lower the arm. In order to create this sub-procedure, you will need to select a new 'START' symbol from the menu on the left side of the screen on the software.
  - c. The third sub-procedure will begin with a new 'START' symbol and should be named 'SPIN.' This sub-procedure will spin the passenger cars that are raised by the arm on the ride.
 

*(Science and Technology)*
2. \* Write a second program (using a second start) that will close the ride down if the emergency button is pressed. This program should return the ride to the down position, and stop it spinning to allow passengers to exit safely.
 

*(Science and Technology)*
3. \*\* Edit your program so that it will start the passenger cars spinning slowly as the ride's arm begins to rise. When the arm reaches a vertical position, the passenger cars will spin fast both forward and backwards while the LEDs on the arm flash (top and bottom LED will flash red and the center LED will flash green). The passenger car will slow and the arm will begin to move downward and stop when the passenger car is again horizontal to the ground. Name and save your program.
 

*(Science and Technology)*



## Challenge Activities:

As you move through the Challenge Activities listed below, you may have to change the location of some of the components or add additional components to the K'NEX Computer Control Interface. Part of the learning process is understanding when, where and how to make those changes.

1. \* Compare and contrast the two (2) gear systems that are found in the Super Spinner Ride.
  - a. Compute the gear ratio of each of the gear systems.
  - b. Identify whether the gear systems are geared up or geared down.
  - c. Describe what would happen if the two gears in each system were switched with one another.  
*(Science, Technology, Engineering and Mathematics)*
2. \* Identify and name as many simple machines as you can in your model. What type of simple machine do they represent? Describe whether each machine multiplies force, multiplies distance, and/or changes the direction of force.  
*(Science and Technology)*
3. \* Determine the cost of the materials that are used to build the K'NEX Super Spinner Ride.
  - a. Make a data chart for this activity in your STEM Journal and include all of your calculations
  - b. Place your answer on the board in the spot indicated by your teacher. *(Teacher Note: Set aside space on the white board or chalk board for each team to list their cost of materials so that the costs are visible to the entire class.)*
4. \*\* Prepare a bill for the cost of the K'NEX Super Spinner Ride project.

**First**, determine the cost of the materials that are used to build the super spinner ride system.

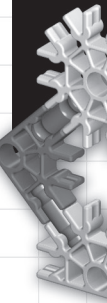
**Second**, include the cost of labor required to design and build the K'NEX Super Spinner Ride. The ride project will require that two employees work for 50 hours each on the actual design of the ride. These designers each make \$150 per hour. Twenty builders will construct the ride in 15 eight-hour days. Five of the builders are master metal workers and they each make \$42.00 per hour. The remaining workers are general construction workers and they make \$28.00 per hour.

**Third**, include the cost of labor required to develop the software program that will operate the ride. One programmer will work for 16 hours to program the ride to operate efficiently and safely. The programmer makes \$125.00 per hour.

**Fourth**, add up all of the costs associated with the project and include a profit for your company that is 35% higher than the total of the other four costs. Prepare a bill for the project that includes all of the costs with 35% added to each of the categories.

*(Teacher Note: This is an excellent opportunity for students to design a name and logo for their company. With those in hand, the students can prepare an official invoice to submit to their customer.) (Technology, Engineering, and Mathematics)*

5. \* Use your team's creativity and imagination to design an exciting program to operate the Super Spinner Ride. This program should include all of your team's best ideas and include each of the LEDs at some point during the ride.  
*(Science and Technology)*
6. \*\* Review the program you just designed for the Super Spinner Ride. Edit that program to include three instances where a push button is used to begin or end a segment of the ride.  
*(Science and Technology)*





## Objectives:

The students will demonstrate the ability to:

- ✓ Design programs using reed switches to coordinate the operation of two sides of a bascule bridge model.  
*(Science and Technology)*
- ✓ Design programs that employ multiple input devices and output devices.  
*(Science and Technology)*
- ✓ Complete a research project designed to improve their understanding of the history, power systems, and applications of bascule bridges.  
*(Science, Technology, and Engineering)*
- ✓ Design a pencil and paper technique or a spreadsheet to calculate the cost of materials for a project.  
*(Engineering and Mathematics)*
- ✓ Compute materials costs, wages, and profits to produce an invoice for a bridge building project.  
*(Technology, Engineering, and Mathematics)*

## Context:

Your team is now ready to take on your fourth project. There is a river in the industrial section of your city. A new interstate highway will pass through the area and it is important that river traffic is not interrupted by the new highway. The river carries raw materials to local industries and finished products to buyers around the world. The Bascule Bridge planned for the city will be computer controlled to operate efficiently and include safety systems that will protect both the highway and the river traffic.

**Good Luck!**

## Requirements:

For this activity you are required to:

1. Make daily entries in your STEM Journal.  
*(Teacher Note: Help students to realize the importance of keeping records and journaling. Inform students of the materials they must include in their STEM Journals.)*
2. List the K'NEXions Chart for all of the Learning Tasks and Challenge Activities your team completes.  
*(Teacher Note: A reproducible template page of K'NEXions Charts is included in this guide.)*
3. List and describe the steps in your programs. Keep a record of changes you made to programs as you improved them.  
*(Teacher Note: (Teacher Note: Students should list and describe their programs in their STEM Journals. If students have the ability to print their programs the copies can be place in their STEM Journals.)*
4. Include all calculations, charts, and graphs you prepare in your STEM Journal.
5. Name and save all of the programs that you write during this series of projects.  
*(Teacher Note: Remind students to select program names that are descriptive of the actions they direct and to include the lesson number they are associated with.)*



## Construction:

Use the instructions to build the K'NEX Bascule Bridge.

*(Technology and Engineering)*

Ensure that all of the electronic components have been connected to the K'NEX Interface before you begin work.

*(Teacher Note: The K'NEXions Chart outlines the placement of the LEDs, motors, push button, buzzer, and reed switches for the Learning Tasks in this lesson. The students will find this information in graphic form in the Building Instructions.)*

### K'NEXions Chart

K'NEX Bascule Bridge

Inputs	Motors	Outputs
		6
		5
4		4
3 Push Button		3
2 Right Reed Switch	B - Motor 2	2
1 Left Reed Switch	A - Motor 1	1

## Learning Tasks:

Complete the learning tasks using both the K'NEX Bascule Bridge SCE on the computer, the K'NEX model, and K'NEX Interface.

*(Teacher Note: Encourage students to complete these learning tasks using the K'NEX Bascule Bridge SCE before they program the computer to operate the model with the K'NEX Computer Control Interface.)*

Program the Bascule Bridge so that it will operate safely and efficiently for both the highway traffic that will pass over it and the river traffic that will pass under it.

- \* Write a program that will raise one side of the bridge until the reed switch reaches a magnet and switches on to stop the bridge. (When working with the actual K'NEX model you may need to modify the positions of the magnet on the side of the bridge where you are working so that it consistently switches on the reed switch.)  
*(Science and Technology)*

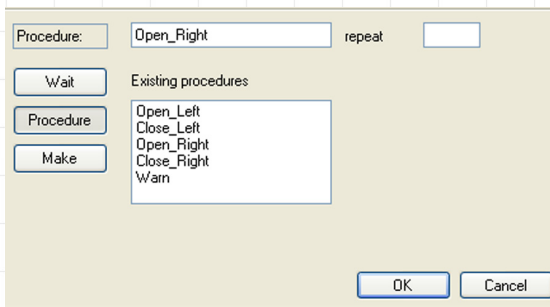
- \*\* Write a program to operate one side of the bridge using sub-procedures. Click on the 'START' symbol on your existing program. You are now going to create two sub-procedures which will each perform one specific task.

Click on the 'START' symbol on your existing program. Change it to a sub-procedure by clicking on the Procedure Button (lower right-hand section of the screen). Name the procedure 'Open\_Right' and click 'OK.'

A sub-procedure must be made part of a program in order to operate. Begin a new program by selecting a new 'START' symbol. Select a process symbol (left side tool bar) and drag it to a location below the 'START' symbol you just created. Click the 'Procedure' button (lower right-hand section of the screen). Select your 'OPEN' sub-procedure and click 'OK' to add it to the new program.

Create a sub-procedure that closes the one side of the bridge. Name it 'CLOSE' and add it to your main program. Test your program to determine if the bridge opens and closes as you expect. Save your program.  
*(Science and Technology)*

- \*\* Edit the main program so that the bridge only opens after the Push Button has been pressed. Make sure to save this new program with a different name.  
*(Science and Technology)*



## Challenge Activities:

As you move through the Challenge Activities listed below, you may have to change the location of some of the components or add additional components to the K'NEX Computer Control Interface. Part of the learning process is understanding when, where and how to make those changes.

- 1.\* Write a program that will cause both sides of the bridge to open and close.  
*(Science and Technology)*
- 2.\*\* Add a Red & Green LED to one side of the bridge that will control the movement of highway traffic both when the bridge is closed and when it is open. Write a program that will open and close the bridge and automate the operation of the LEDs to control highway traffic that may be approaching the bridge.  
*(Science, Technology, and Engineering)*
- 3.\* Add a Buzzer to the Bascule Bridge model and use it to warn cars and foot traffic that the bridge is about to begin moving.  
*(Science and Technology)*
- 4.\* Research bridges and create and present a multimedia presentation about bascule bridges to the entire class. The following suggestions and questions will help to focus your research.
  - How have bascule type bridges served mankind through history?
  - What materials were used to build the first bascule bridges?
  - Are bascule bridges better suited for short spans or long spans?
  - What types of power systems have been used through history to operate bascule bridges?
  - Describe four famous bascule type bridges that are in use today.  
*(Science, Technology, and Engineering)*
- 5.\* Determine the cost of the materials that are used to build the K'NEX Bascule Bridge.
  - a. Make a data chart for this activity in your STEM Journal and include all of your calculations
  - b. Place your answer on the board in the spot indicated by your teacher. *(Teacher Note: Set aside space on the white board or chalk board for each team to list their cost of materials so that the costs are visible to the entire class.)*
  - c. How do your results compare with other groups who have completed the challenge? If answers vary, devise and implement a plan to check your work. *(Teacher Note: Provide time for the teams to compare their answers and to correct any differences. The Cost Per Piece Chart has been provided in an editable format allowing you to assign costs to the K'NEX pieces that are appropriate for the students you are working with. Use the same costs for all 5 lessons. This is an excellent project to complete with spreadsheet software if students have experience with spreadsheets. Students can design data charts, enter formulas, and compute both the cost per each type of piece and the total cost of the pieces used in the project. If the students designed a spreadsheet to compute the cost of materials in Lesson 2 they should be able to add a column to that spreadsheet to compute the material costs for the K'NEX Bascule Bridge.)*  
*(Science, Engineering and Mathematics)*

5. \*\* Prepare a bill for the cost of the K'NEX Bascule Bridge project.

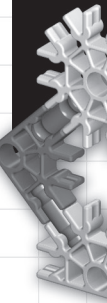
**First**, determine the cost of the materials that are used to build the bascule bridge system.

**Second**, include the cost of labor required to design and build the K'NEX Bascule Bridge. The project will require that two engineers work for 65 hours each designing the bridge. These designers each make \$150 per hour. One hundred and ten (110) bridge builders will construct the bridge in 90 eight-hour days. Forty of the builders are master metal workers and they each make \$42.00 per hour. The remaining workers are general construction workers and they make \$28.00 per hour plus a \$5.00 per hour bonus for this project.

**Third**, include the cost of labor required to develop the software program that will operate the bridge. Two programmers will work for 30 hours each to program the bridge to operate efficiently and safely. Each programmer makes \$125.00 per hour.

**Fourth**, add up all of the costs associated with the project and include a profit for your company that is 44% higher than the total of the other four costs. Prepare a bill for the project that includes all of the costs with 44% added to each of the categories.

*(Teacher Note: This is an excellent opportunity for students to design a name and logo for their company. With those in hand, the students can prepare an official invoice to submit to their customer.)*  
*(Technology, Engineering, and Mathematics)*





### Objectives:

Students will demonstrate the ability to:

- ✓ Design one or more programs using variables to control a complex system.  
*(Science and Technology)*
- ✓ Edit programs to add greater detail and to minimize the steps to complete a task or series of tasks.  
*(Science and Technology)*
- ✓ Prepare a cost and profit analysis of five projects undertaken by a business that includes data, charts, and graphs.  
*(Science, Technology, Engineering, and Mathematics)*
- ✓ Investigate the various systems that are included in a modern elevator to keep riders safe and move them quickly from floor to floor.  
*(Science, Technology, and Engineering)*
- ✓ Use problem solving strategies to determine the best floors to stage elevators on during the day to make them as efficient as possible.  
*(Science and Technology)*

### Context:

Your team is now ready to take on your fifth and final project. This project takes on special importance as it will serve senior citizens who visit the new Senior Community Center in your town. Your company has been contracted to construct and program a new elevator system that will allow the Senior Center to safely move senior citizens from floor to floor. As a donation to the community, your company will donate some of its services on this project to the Senior Center so they can use the savings to outfit their new exercise room.

**Good Luck!**

### Requirements:

For this activity you are required to:

1. Make daily entries in your STEM Journal.  
*(Teacher Note: Help students to realize the importance of keeping records and journaling. Inform students of the materials they must include in their STEM Journals.)*
2. List the K'NEXions Chart for all of the Learning Tasks and Challenge Activities your team completes.  
*(This chart will be provided by your teacher.) (Teacher Note: A reproducible template page of K'NEXions Charts is included in this guide.)*
3. List and describe the steps in your programs. Keep a record of changes you made to programs as you improved them.  
*(Teacher Note: Students should list and describe their programs in their STEM Journals. If students have the ability to print their programs the copies can be placed in their STEM Journals.)*
4. Include all calculations, charts, and graphs you prepare in your STEM Journal.
5. Name and save all of the programs that you write during this series of projects.  
*(Teacher Note: Remind students to select program names that are descriptive of the actions they direct and to include the lesson number they are associated with.)*



## Construction:

Use the instructions to build the K'NEX Elevator.  
*(Technology and Engineering)*

Ensure that all of the electronic components have been connected to the K'NEX Interface before you begin work.

*(Teacher Note: The K'NEXions Chart below outlines the placement of the LEDs, motors, push buttons, and reed switches for the Learning Tasks in this lesson. The students will find this information in graphic form in the Building Instructions.)*

## K'NEXions Chart

K'NEX Elevator

Inputs	Motors	Outputs
		6
		5
4		4
3 Reed Switch 2		3 LED
2 Reed Switch 1	B	2 LED
1 Push Button	A Motor	1 LED

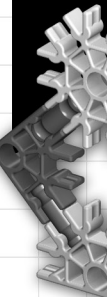
## Learning Tasks:

Complete these learning tasks using both the K'NEX Elevator SCE on the computer, the K'NEX model and the K'NEX Interface.

*(Teacher Note: Encourage students to complete these learning tasks using the K'NEX Elevator SCE before they program the computer to operate the model with the K'NEX Computer Control Interface.)*

Program the Elevator so that it will operate safely and efficiently for the senior citizens at the Community Center.

1. Write a program that has the elevator car move from floor one (1), to floor two (2), to floor three (3), that loops.  
*(Science and Technology)*
2. Edit your program to use the three LEDs to show the floor the elevator has reached.  
*(Science and Technology)*
3. Write a new program that uses two variables. The first variable is FLOOR – this stores the current location of the elevator. The second variable is called GOTO and contains the floor the elevator needs to travel to next. By comparing the two variables (IS GOTO > FLOOR) you can work out if the elevator car should be travelling up or down to the next floor.
  - a. Check if the elevator has arrived by using the variable in the IS command (IS INPUT GOTO ON).
  - b. You can also use the variable to switch on the appropriate LED (SWITCH ON GOTO)
  - c. Use the RANDOM function to select which floor to go to next. RANDOM(3) will give a value between 0 and 2, as we need a value between 1 and 3 we simply add one! (RANDOM(3)+1)
  - d. If your program is correct, it will randomly pick a floor and your program will send the elevator to it forever!
  - e. Using variables is more complex, but it makes smaller, clearer programs, which are easier to edit in the future.  
*(Science and Technology)*



## Challenge Activities:

As you move through the tasks and challenges listed below, you may have to change the location of some of the components or add additional components to the K'NEX Computer Control Interface. Part of the learning process is understanding when, where and how to make those changes.

1. \* Complete an investigation and necessary research to explain how simple machine technology improves the operation of this elevator. Additionally, describe how other elevator systems use similar or different simple machines to improve their operation.  
*(Science and Technology)*
2. \*\* Identify the various systems that make elevators operate safely and efficiently (i.e., safety, electrical, etc.). Prepare a pie chart on poster board or a large sheet of drawing paper that briefly highlights each of the systems and explains how each system serves the elevator. Be prepared to present your poster to your classmates who will be acting as the Board of Directors of the Senior Center.  
*(Science, Technology, and Engineering)*
3. \*\* Research the history of elevators. How have advances in elevator technology led to advances in the architecture of buildings and mechanical systems within those buildings? Use a multimedia format (i.e., PowerPoint) to present the results of your research.  
*(Science, Technology, and Engineering)*
4. \* Sketch an elevator system on drawing paper and label all of the major components.  
*(Technology and Engineering)*
5. \* Describe four (4) different types of elevators and indicate how they operate. Present this information in the form of a formal, written report to the Senior Center's Board of Directors.  
*(Technology and Engineering)*
6. \*\* Investigate and present information about common strategies used to stage elevators on different floors during the day to support maximum operational efficiency in a tall building. Consider a fifteen story office building that has a bank of 4 elevators. If the elevators have not been called to a floor, what floor(s) should they wait on for their next call? Explain your answer. Would your answer vary at different hours of the day?  
*(Science and Technology)*
7. \* Determine the cost of the materials that are used to build the K'NEX Elevator.
  - a. Make a data chart for this activity in your STEM Journal and include all of your calculations
  - b. Place your answer on the board in the spot indicated by your teacher.  
*(Teacher Note: Set aside space on the white board or chalk board for each team to list their cost of materials so that the costs are visible to the entire class.)*

How do your results compare with other groups who have completed the challenge? If answers vary, devise and implement a plan to check your work.  
*(Teacher Note: Provide time for the teams to compare their answers and to correct any differences. This is an excellent project to complete with spreadsheet software if students have experience with spreadsheets. Students can design data charts, enter formulas, and compute both the cost per each type of piece and the total cost of the pieces used in the project. If the students designed a spreadsheet to compute the cost of materials in Lesson 2 they should be able to add a column to that spreadsheet to compute the material costs for the K'NEX Elevator.)*  
*(Science, Engineering, and Mathematics)*
8. \*\* Prepare a bill for the cost of the K'NEX Elevator project.

**First**, determine the cost of the materials that are used to build the K'NEX Elevator.

**Second**, include the cost of labor required to design and build the K'NEX Elevator. The elevator project will require that two engineers work for 14 hours each on the design of the elevator. These engineers each make \$150 per hour. Ten workers will construct the elevator in 7 eight-hour days. Three of the builders are master metal workers and they each make \$42.00 per hour. The remaining workers are general construction workers and they make \$28.00 per hour.

**Third**, include the cost of labor required to develop the software program that will operate the bridge. One programmer will work for 8 hours to program the elevator to operate efficiently and safely. The programmer makes \$125.00 per hour.

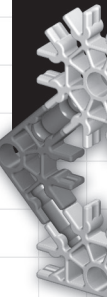
**Fourth**, add up all of the costs associated with the project and include a profit for your company that is 35% higher than the total of the other four costs. Prepare a bill for the project that includes all of the costs with 35% added to each of the categories. Your company has agreed to donate some of their services for this project. You have been directed to reduce the reported cost of materials by a total of 10%. Show the 10% donation on the bill and subtract that amount from the total cost of the project.

*(Teacher Note: This is an excellent opportunity for students to design a name and logo for their company. With those in hand, the students can prepare an official invoice to submit to their customer.)*  
*(Technology, Engineering, and Mathematics)*

9. \*\* Your team has finally finished the five projects that you were assigned. Prepare a report for your supervisor that:

- Lists all of the projects
- Lists the materials costs plus profit for each project.
- Lists the labor costs plus profit for each project.
- Lists the total cost of materials for all five projects.
- Lists the total labor cost for all five projects.
- Lists the total profit for all five projects.
- Lists the donation made on behalf of the company to the new Senior Center.
- Includes a bar graph that presents the total cost of each project.
- Includes a bar graph that presents the total profit of each project.

*(Teacher Note: This is an excellent opportunity for students to use spreadsheet technology to complete their data presentations and graphs.)*  
*(Science, Technology, Engineering, and Mathematics)*



# K'NEXions Chart

Model \_\_\_\_\_

Inputs	Motors	Outputs
		5
4		4
3		3
2	B	2
1	A	1




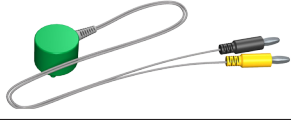







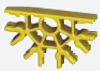




Model \_\_\_\_\_

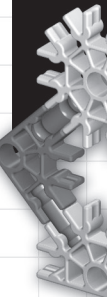
Inputs	Motors	Outputs
		5
4		4
3		3
2	B	2
1	A	1





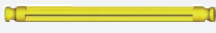



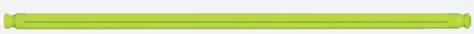









Model \_\_\_\_\_

Inputs	Motors	Outputs
		5
4		4
3		3
2	B	2
1	A	1

# Cost Per Piece Chart

	ITEM	COST	QTY	TOTAL
<b>ELECTRONIC COMPONENTS</b>				
	LED	\$ _____	X ____ =	\$ _____
	BUZZER	\$ _____	X ____ =	\$ _____
	PUSH BUTTON SWITCH	\$ _____	X ____ =	\$ _____
	REED SWITCH	\$ _____	X ____ =	\$ _____
	MAGNET	\$ _____	X ____ =	\$ _____
	MOTOR	\$ _____	X ____ =	\$ _____
<b>CONNECTORS</b>				
	PURPLE	\$ _____	X ____ =	\$ _____
	WHITE	\$ _____	X ____ =	\$ _____
	RED	\$ _____	X ____ =	\$ _____
	ORANGE	\$ _____	X ____ =	\$ _____
	GREEN	\$ _____	X ____ =	\$ _____
	YELLOW	\$ _____	X ____ =	\$ _____
	BLUE	\$ _____	X ____ =	\$ _____
	DARK GREY	\$ _____	X ____ =	\$ _____
	LIGHT GREY	\$ _____	X ____ =	\$ _____
	BLACK	\$ _____	X ____ =	\$ _____



	ITEM	COST	QTY	TOTAL
	BLUE CLIP	\$ _____	X ____ =	\$
	TAN CLIP	\$ _____	X ____ =	\$
<b>RODS</b>				
	GREEN	\$ _____	X ____ =	\$
	BLUE	\$ _____	X ____ =	\$
	YELLOW	\$ _____	X ____ =	\$
	RED	\$ _____	X ____ =	\$
	WHITE	\$ _____	X ____ =	\$
	LIGHT GRAY	\$ _____	X ____ =	\$
	YELLOW/GREEN FLEXIBLE	\$ _____	X ____ =	\$
<b>GEARS, PULLEYS AND TRIM</b>				
	YELLOW GEAR	\$ _____	X ____ =	\$
	BLUE GEAR	\$ _____	X ____ =	\$
	RED GEAR	\$ _____	X ____ =	\$
	PULLEY - MEDIUM	\$ _____	X ____ =	\$
	PULLEY - SMALL	\$ _____	X ____ =	\$
	STRING	\$ _____ /per foot	X ____ =	\$
	SPACER - BLUE	\$ _____	X ____ =	\$
	SPACER - GREY	\$ _____	X ____ =	\$
	WIRE CLIP - DRK GRAY	\$ _____	X ____ =	\$