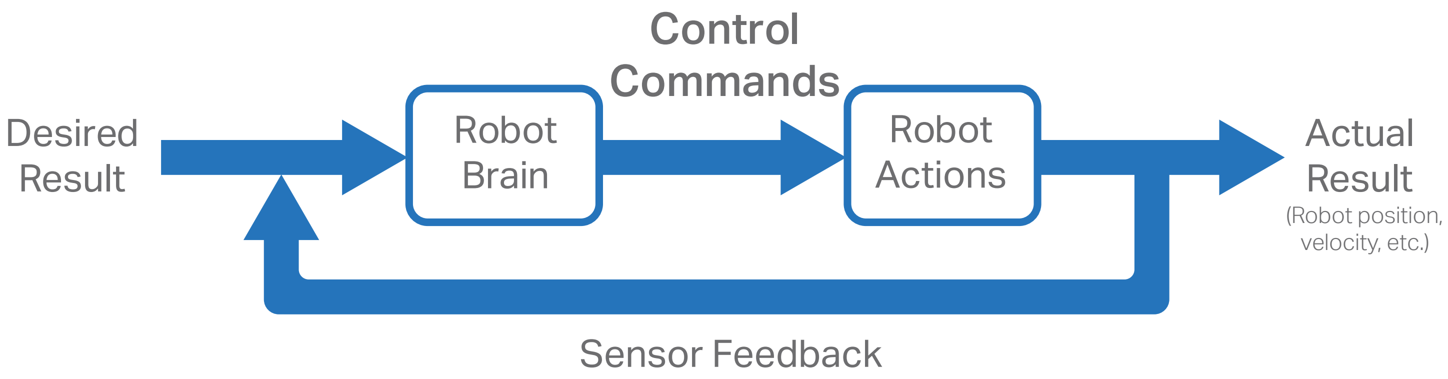
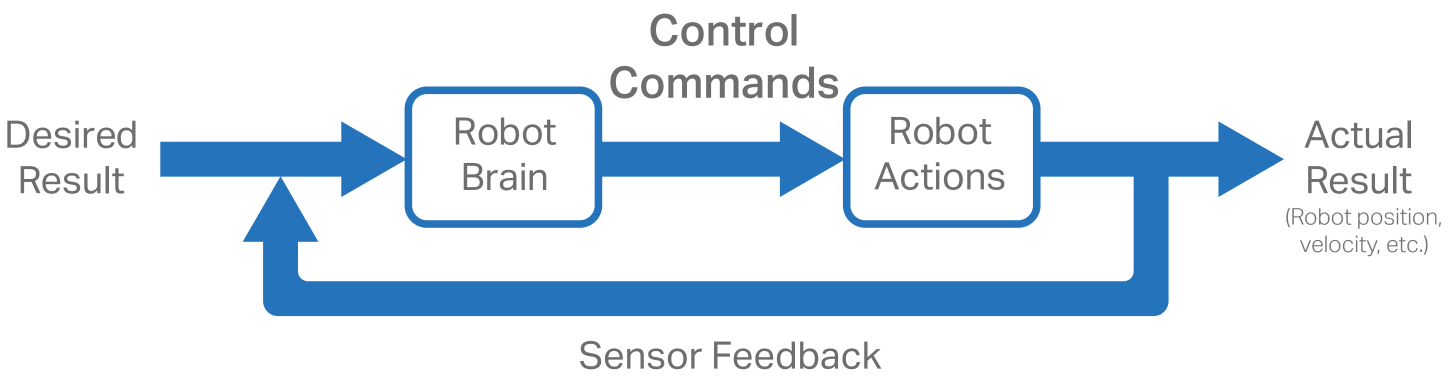
Smarter Machines





K.1

Smarter Machines

Unit Overview:

This unit will allow students to further explore sensors and programming with VEX IQ. Students will also use the VEX IQ robots they have created thus far to develop a better understanding of control.

Unit Content:

- Key Terminology: Control, Open-Loop Control Systems, Closed-Loop Control Systems
- Sensor Review

Unit Activities:

- Robot Build using Robot Challenge Evaluation Rubric. You may be instructed to build or use a specific robot in this unit. See your teacher for details.
- Unit Challenges. You will be instructed to tackle one or more of the given unit challenges for Clawbot IQ with Sensors, Armbot IQ, or a custom created VEX IQ robot.
- Completion of Idea Book Pages with robot programming and testing

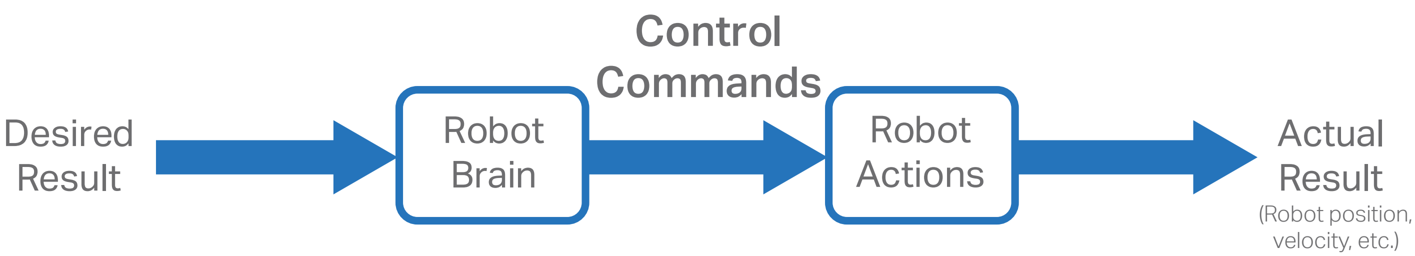
Note: Separate copies and/or printouts of activities may be used for student work. Please see your teacher BEFORE writing in this guide. Visit www.vexiq.com/curriculum to download and print PDFs of all exercises!

K.2

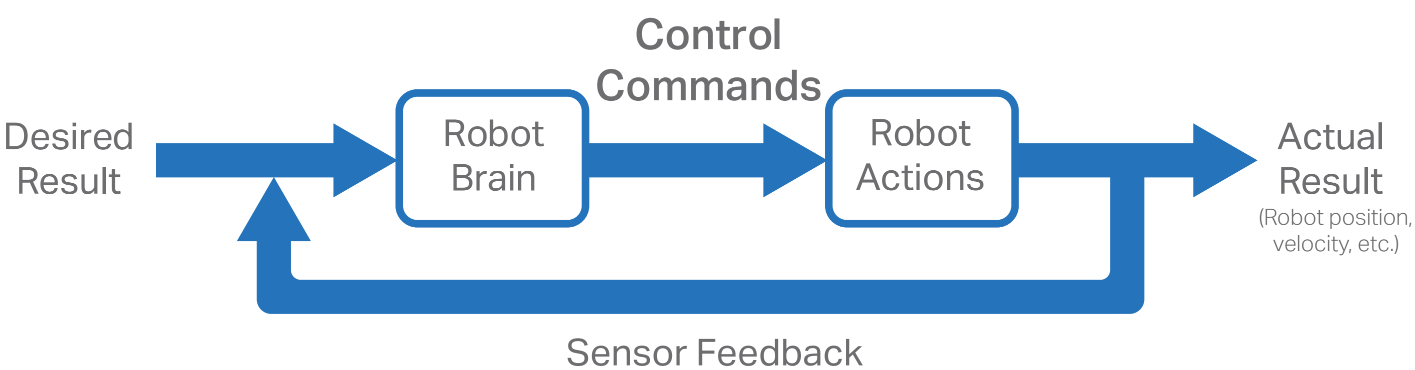
Key Concepts and Terminology

Learning to manipulate and use your VEX IQ controller well is one way to gain better control over your robot, but that is a purely Teleoperated solution. What about Autonomous and Hybrid robots? Well, you've already seen in the Smart Machines Unit that using sensors and programming to create desirable Autonomous and Hybrid solutions can lead to some amazing solutions. Before furthering your programming skills to create more advanced solutions, you must first have an understanding of what **Control** is and the types of control systems that can be created.

Control, simply, is defined as the ability to direct the actions or function of something. Having better **Control** over your VEX IQ creations will lead to seeing more expected repeatable behavior and more positive results in general. **Open-Loop Control Systems** are also called **Non-Feedback Control Systems**. This type of control system is generally more simplistic and easier to implement. It cannot correct for errors or disturbances along the way. In the **Open-Loop Control System** shown below, a desired result is programmed and/or sent to the Robot Brain, the Robot Brain sends control commands to the robot's subsystems, telling them to take certain actions, and those actions lead to an actual result. Using the VEX IQ Smart Motors to drive straight forward autonomously for five seconds is one example of **Open-Loop Control**.



Systems that utilize feedback are called **Closed-Loop Control Systems**. These systems tend to be more complex and more difficult to implement, but can often lead to more repeatable and predictable control. The feedback in a **Closed-Loop Control System**, like the one shown below, is used to recognize +/- differences between desired and actual results and correct for those differences along the way. Using the VEX IQ Gyro Sensor to maintain a constant heading/direction while a robot drives autonomously is one example of **Closed-Loop Control**.



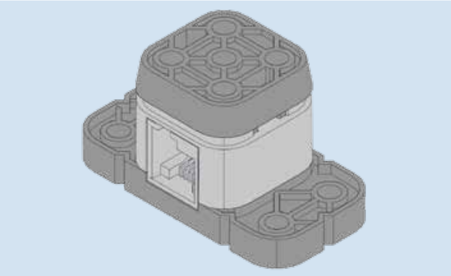
Open-Loop or Closed-Loop, Which is Best for Me?

There is no one answer. Control System type choices depend on your time, resources, expertise, the environment your robot will be operating in, the level of control and error correction that you need or desire, and any other constraints that are presented before you.

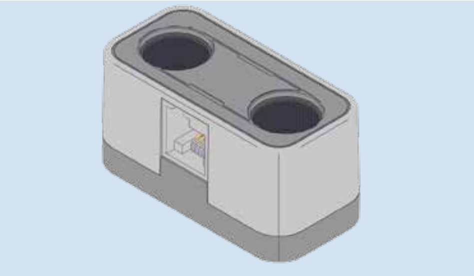
K.3

VEX IQ Sensor Review

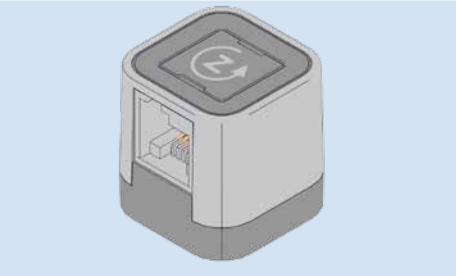
Here is a brief review of what you learned about each VEX IQ Sensor in the Smart Machines unit. Use this chart to help make decisions about how you might solve the challenges in this unit.



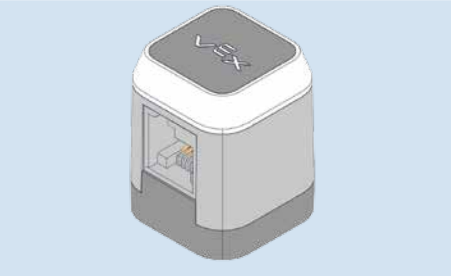
Bumper Switch
Allows for the sense of touch in the VEX IQ platform. Detect a wall, obstacle, or limit mechanism movement.



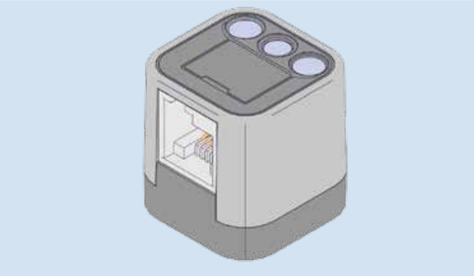
Distance Sensor
Uses ultrasonic sound waves to measure distance. Measures distance from 1 inch to 10 feet. Commonly used to avoid obstacles.



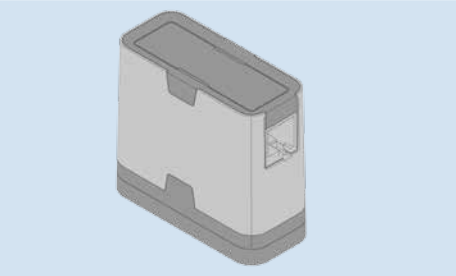
Gyro Sensor
Measures turn rate and calculates direction. Frequently used in autonomous robot navigation and turning.



Touch LED
Smart Sensor with red, green, blue LEDs. Constant on, off, or blink at any desired rate. Touch sensor with finger for interaction.



Color Sensor
Detects the color of objects. Measures independent red, green, and blue in 256 levels each.



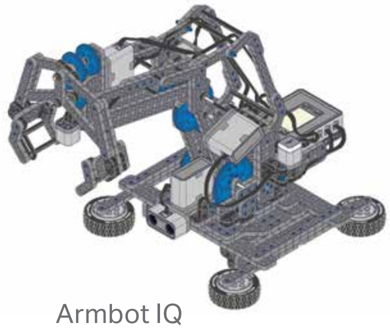
Smart Motor
Commands and measures speed, direction, time, revolutions and/or degrees of turn using its Encoder.

K.4

Smarter Machines Unit Robots

Your teacher might instruct you to build or use one or more of these robots to solve a Smarter Machines challenge. Follow your teacher's instructions for details!

Clawbot IQ with Sensors
Separate Assembly Instructions



Armbot IQ
Separate Assembly Instructions

Your Own Creation
See Your Teacher For Details

K.5

Smarter Machines Unit Challenges

You will be completing one or more of the challenges below. Use a VEX IQ Robot, the VEX IQ Sensors, your VEX IQ Programming Software (there are multiple options and you should be familiar with your software from the Smart Machines unit), the Robot Challenge Evaluation Rubric, and as many copies of the Idea Book Page as necessary to solve the challenge problem and document your process.

Possible Clawbot IQ with Sensors Challenges:

1. Program the robot AUTONOMOUSLY as follows (no Controller):

- The robot claw should start by holding an object, like a ball, cube or plastic cup in the claw
- Your program should start running autonomously with a tap of the Touch LED
- Then turn 360 degrees using the Gyro and Smart Motors or just the Smart Motors
- Have the robot arm lift up, open its claw, and drop the object
- Have the Robot Brain display, "I AM DONE" and the Touch LED glow Red at conclusion of the program

2. Program the robot for the following HYBRID functions (Robot is controlled with Controller):

- Program the robot arm joint to stop turning in the downward direction when the arm presses the Bumper Switch in. Each time the arm is lifted and dropped, the Bumper Switch should protect a robot driver from dropping the arm too far.
- Program the color sensor to recognize an object's color when holding it and print that color name on the robot LCD screen when the object is being held. The object should be red, blue, or green and easy to manipulate (ball, cube, or plastic cup for example)
- Program the Distance Sensor to stop the robot 100 mm away from a wall or obstacle, preventing a driver from hitting that obstacle.

*Test these functions out one at a time or all together using your controller

3. Teacher Created Challenge

Possible Armbot IQ Challenges:

1. Program the robot AUTONOMOUSLY as follows (no Controller):

- Item delivery. Program the robot to pick up items (balls, cubes, etc) from a specific location and deliver them to a second specific location, one at a time.

*Note objects may be placed/and removed one at a time by a teacher or classmate

2. Program the robot AUTONOMOUSLY as follows (no Controller):

- Color sorter. Program the robot to pick up items (balls, cubes, etc) that are 2 or 3 different colors (use red, blue, and/or green items), one at a time, from a specific location and deliver them to color specific destinations (one destination for red, another for blue, a third for green).

*Note objects may be placed/and removed one at a time by a teacher or classmate

3. Teacher Created Challenge

Possible Challenges Using a Custom Created VEX IQ Robot:

1. Create & Program a VEX IQ robot that successfully navigates a maze autonomously using sensors
2. Create & Program a VEX IQ robot that successfully delivers an object to an exact location autonomously using sensors
3. Teacher Created Challenge

K.6

Robot Challenge Evaluation Rubric

Evaluation Criteria	Expert = 4	Proficient = 3	Emerging = 2	Novice = 1	Assessment	Comments
Design & Process Criteria						
Creating Viable Solutions to the stated Challenge	Multiple, well developed solutions exist meeting all critical criteria	Multiple solutions are evident & one is developed meeting majority of criteria	Multiple, undeveloped solutions are evident	A solution that may or may not be developed is evident		
Simple and/or Complex Systems	All simple and/ or complex systems are identified & function efficiently	Functioning simple and/ or complex systems exist	Multiple simple systems exist that may function	One functioning simple system exists (e.g. drivetrain only)		
Design Process (documented in Idea Book or Engineering Notebook)	Formal design process utilized, documented & enhances efficiency	Formal design process utilized and fully documented	Formal design process utilized consistently	Some evidence that formal design process was utilized		
Utilization of Resources (materials and parts, information and instructions, people, and time)	Resources used within constraints, efficiency maximized	Resources utilized to maximize efficiency	Evidence that some resources utilized meeting intended purpose	A few resources (e.g. tools & materials) utilized randomly		
Technical Criteria						
Programming (Autonomous and/ or teleoperated)	Efficiency evident in all program-ming	Consistency evident in one or more parts of pro-gramming	Functional, but inconsistent program-ming	Program-ming incomplete or rarely functional		
Control Systems	Completely functional and consistent control systems	Consistently functional control systems	Functional, but inconsistent control systems	Non-functional or incomplete control systems		
Electrical Systems	Battery charged. Wire routing safe, efficient, & completely functional.	Battery charged. Wire routing safe & consistently functional.	Functional, but inconsistent (battery or wiring issues)	Non-functional or incomplete (battery and wiring issues)		
Mechanical Systems	Completely functional and consistent mechanical systems	Consistently functional mechanical systems	Functional, but inconsistent mechanical systems	Non-functional or incomplete/ unsafe mechanical systems		

K.6 cont.

Robot Challenge Evaluation Rubric

Evaluation Criteria	Expert = 4	Proficient = 3	Emerging = 2	Novice = 1	Assessment	Comments
Unifying Themes (This area emphasizes the Interaction of Science, Technology, & Human Endeavor)						
Communication (written, electronic and/or oral as defined by the teacher)	Sophisticated and highly efficient communication for all audiences	Purposeful, consistent, effective communication	Purposeful, fairly consistent communication	Communication very inconsistent and lacks purpose		
Teamwork	Integrated teamwork that maximizes outcomes is evident	Teammates fully define roles, goals, & work together	Teammates partially define roles, goals, & work together	Participants function separately within a group		
Creativity	Robot is unique, imaginative, and functional	Robot is unique and/or imaginative in multiple ways	Robot clearly shows a unique and/or imaginative element	Unique and/or imaginative element(s) unclear		

Rubric Adapted from Rubric and Evaluation Criteria for Standards-Based Robotics Competitions & Related Learning Experiences – TSA, 2005

K.7

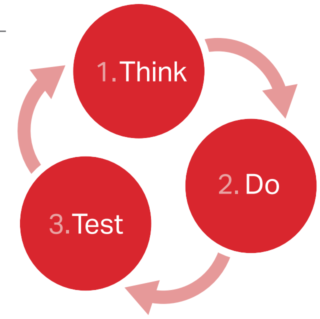
Smarter Machines Idea Book Page: Program Planning & Troubleshooting

Student Name(s): ____

Teacher/Class: ____________________ Date: _________ Page #: _____

Instructions:

Use as many copies of this Idea Book Page as you need to help plan, execute, and troubleshoot a custom program written for your VEX IQ robot with your programming software.



Describe what you want your program to be able to do here:	
Describe the device/robot you will be programming:	List the sensors that will be used in your program:

"THINK" Write step-by-step program instructions here.	"DO" Write your program using programming software and make notes here as you work.	"TEST" Does this step of your program function as expected? What needs improvement (NI)?
		Yes No NI:
		Yes No NI:
		Yes No NI:
		Yes No NI:
		Yes No NI:
		Yes No NI:
		Yes No NI:
		Yes No NI:

Remember: Problems ARE NOT failures, they are an expected part of the design process!