Unit Overview

Unit 1 – Introduction to VEX and Robotics

VEX lab kits bring robotics into the classroom, making it a fun and educational experience for all. In this introductory unit, you review the kit and parts that make up the VEX Protobot. In addition, you start using Autodesk® Inventor®. This solid modeling software makes it easy to design and analyze robot parts.

Unit Objectives

After completing Unit 1: Introduction to VEX and Robotics, you will be able to:

- Review the basic components of a robot.
- Review the parts in the VEX Classroom Lab Kit.
- Work with VEX parts.
- Get started with Autodesk Inventor.
- Identify and use the different parts of the VEX Classroom Lab Kit to complete subassemblies in the creation of a tumbler.
- Build a robot component.

Unit 2 – Introduction to Autodesk Inventor

In Unit 2: Introduction to Autodesk Inventor, you review the Autodesk® Inventor® user interface. The main components are the main menu, the standard toolbar, panel bar, browser, shortcut menus, and shortcut keys.

You also review the modeling process with Autodesk Inventor. This includes creating sketches, parts, assembling parts, and documenting parts and assemblies.

Unit Objectives

After completing Unit 2: Introduction to Autodesk Inventor, you will be able to:

- Review the Autodesk Inventor modeling process.
- Review the Autodesk Inventor user interface.

Unit 3 – Building a Protobot

In Unit 3: Building a Protobot, you build a Protobot, a robot designed to utilize the parts of the VEX Classroom Kit to teach basic assembly methods and robot wiring. After completing this unit you will have a working, ready-to-compete robot.

The concepts involved in building your Protobot have countless real-world applications. In STEM Connections, we have presented a scenario involving the design of a housecleaner robot. After completing the Think Phase and Amaze Phase in Unit 3: Building a Protobot, you will see how those concepts come into play in the real world.

Unit Objectives

After completing Unit 3: Building a Protobot, you will be able to:

- Demonstrate the engineering design process and develop and maintain an engineering notebook.
- Use Autodesk® Inventor® Professional 2009 to assemble a Protobot frame and create an animated presentation and rendered image of the frame and wheel assembly.
- Identify and use the different parts of the VEX Classroom Lab Kit to complete subassemblies in the creation of a Protobot.
- Manipulate objects and navigate a course with a VEX Protobot.

Unit 4 – Microcontroller and Transmitter Overview

In Unit 4: Microcontroller and Transmitter Overview, you learn about and use the various functions of the VEX Control Subsystem, specifically the Transmitter Microcontroller, as provided by the VEX default code.

Microcontrollers and transmitter technologies have countless applications. In STEM Connections, we use the Mars Pathfinder and Sojourner robotic probes as references to help you see how the concepts found in this unit can be used to solve some very challenging real-world problems.

Unit Objectives

After completing Unit 4: Microcontroller and Transmitter Overview, you will be able to:

- Demonstrate ways to wire a robot using the default setup, relate the controls on the Transmitter to the Motor Ports on the Microcontroller and utilize the Arcade Style Drive Configuration.
- Activate Tank-Style Control (23 Mode).
- Drive a robot with Tank-Style Control (23 Mode).

Unit 5 – Speed, Power, Torque, and DC Motors

In Unit 5: Speed, Power, Torque, and DC Motors, you build a VEX test stand winch that enables you to learn key engineering concepts and principles so you can directly apply mathematics and science to robotics. The test stand will be used again and enhanced in Unit 6: Gears, Chains, and Sprockets.

The concepts regarding speed, power, torque, and DC motors have countless real-world applications. In STEM Connections, we present one application involving the operation of a free fall amusement park ride. After completing the Think and Build phases, you see how the concepts of speed, power, torque and DC motors come into play in the real world.

Unit Objectives

After completing Unit 5: Speed, Power, Torque, and DC Motors, you will be able to:

- Demonstrate the physical concepts of speed, force, torque, power, acceleration, and characteristics of DC Motors.
- Create and define characteristics of a shaft using Autodesk® Inventor® Professional 2009.
- Test a VEX motor and build a simple winch.
- Determine and calculate the free speed and stall torque of a VEX motor.

Unit 6 – Gears, Chains, and Sprockets

In Unit 6: Gears, Chains, and Sprockets, you modify the VEX test stand from Unit 5: Speed, Power, Torque, and DC Motors to learn more key engineering concepts that involve the use of gears, chains, and sprockets, along with key corresponding concepts such as reduction and ratio.

The concepts regarding gears, gear ratios, force, torque, and motor speed have countless real-world applications. In STEM Connections, we have presented a scenario involving the operation of a winch installed on a coast guard helicopter for sea rescue operations. After completing the Think Phase and Build Phase in Unit 5: Speed, Power, Torque, and DC Motors, you will see how those concepts come into play in the real world.

Unit Objectives

After completing Unit 6: Gears, Chains, and Sprockets, you will be able to:

- Identify whether a gear reduction causes a speed reduction or a speed increase, and calculate gear ratios.
- Create a spur gear and animate a gear assembly using Autodesk® Inventor® Professional 2009.
- See the relationship between gearing, speed, and power; and incorporate VEX gears into a design.
- Modify the gearing of a VEX gearbox and understand the effect of gear ratios on speed and torque.

Unit 7 – Advanced Gears

In Unit 7: Advanced Gears, you build a steerable, differential tricycle. You learn about differentials, bevel gears, and spur gears, and you document and communicate your learning in a variety of ways.

The concepts regarding advanced gears such as rack and pinion and worm gears have countless real-world applications. In STEM Connections, we present a scenario involving a rack and pinion system for steering an automobile. After completing the Think Phase and Build Phase in Unit 7: Advanced Gears, you will see how concepts regarding advanced gears come into play in the real world.

Unit Objectives

After completing Unit 7: Advanced Gears, you will be able to:

- Identify rack gears, worm gears, worm wheels, and bevel gears and understand applications for differentials.
- Assemble and drive rack and pinion gears in Autodesk® Inventor® Professional.
- Combine gears into a robot drivetrain and build a steerable VEX robot.
- Determine the effect of a differential on a robot drivetrain.

Unit 8 – Friction and Traction

In Unit 8: Friction and Traction, you modify the differential tricycle to participate in a tractor pull. You learn about the concepts of friction and traction while applying your knowledge of the design process to solve a given problem.

The physics concepts of friction and traction must be considered in countless real-world applications. In STEM Connections, we present one scenario involving friction and traction in the design of a snowmobile. After completing the Think Phase and Build Phase in Unit 8: Friction and Traction, you will see how concepts regarding friction and traction come into play in the real world.

Unit Objectives

After completing Unit 8: Friction and Traction, you will be able to:

- Explain the difference between static and kinetic friction and list the factors which determine traction.
- Create a VEX tire in Autodesk® Inventor® Professional.
- Have a robot ready to compete in a "tractor pull" and be proficient in making simple modifications to VEX robots.
- Take advantage of the principles of friction and traction to modify a robot to pull a greater amount of weight.

Unit 9 – Drivetrain Design 1

In Unit 9: Drivetrain Design 1, you learn the basic principles of drivetrain design, build a basic VEX drivetrain, and test your creation using varying wheelbases. Key concepts from previous units are applied and you document and present your findings.

The concept of a skid steer system has a variety of real-world applications. In STEM Connections, we present a scenario involving the design of a personal golf cart. After completing the Think Phase and Build Phase in Unit 9: Drivetrain Design 1, you will see how skid steering comes into play in the real world.

Unit Objectives

After completing Unit 9: Drivetrain Design 1, you will be able to:

- Describe how turning scrub and turning torque affect a robot's ability to turn, and how chassis geometry affects turning scrub and turning torque.
- Build a gearbox with bevel gears using Autodesk® Inventor® Professional.
- Build a simple VEX drivetrain.
- Describe the relationship between length of wheelbase and turning ability.

Unit 10 – Drivetrain Design 2

In Unit 10: Drivetrain Design 2, you design your own drivetrain, building on knowledge and skills from previous units. You will also calculate, document, and communicate both theoretical and measured speeds for your drivetrain.

The concept of a drive train has a variety of real-world applications. In STEM Connections, we present a scenario involving the design of a pitching machine for baseball and softball. After completing the Think Phase and Build Phase in Unit 10: Drivetrain Design 2, you will see how a drive train comes into play in the real world.

Unit Objectives

After completing Unit 10: Drivetrain Design 2, you will be able to:

- Determine how fast a wheel is rolling based on its rotational speed and calculate the load on a motor based on wheel traction.
- Build a gearbox using bevel gears using Autodesk® Inventor® Professional.
- Apply your VEX expertise gained from prior units to design and build your own drivetrain.
- Calculate theoretical speed of a given drivetrain and explain the differences between the theoretical and measured speeds of a drivetrain.

Unit 11 – Creating a Tank Tread Drive

In Unit 11: Creating a Tank Tread Drive, you learn about tank tread drivetrains. You build a simple tank tread drivetrain, and modify that drivetrain to complete a given challenge using the design process and problem-solving techniques. You then document your process and report on your findings and learning.

The concept of a tank tread drive has a variety of real-world applications. In STEM Connections, we present a scenario involving the use of the tank tread on a bulldozer for earth moving. After completing the Think Phase and Build Phase in Unit 11: Creating a Tank Tread Drive, you have an opportunity to see how tank treads comes into play in the real world.

Unit Objectives

After completing Unit 11: Creating a Tank Tread Drive, you will be able to:

- List the advantages and disadvantages of tank tread drives.
- Animate the installation of the tank tread kit using Autodesk® Inventor® Professional.
- Apply the knowledge from the Unit 11: Creating a Tank Tread Drive.
- Create tank tread drivetrains of varying design.

Unit 12 – Object Manipulation

Object manipulation is one of the primary objectives in most mobile robotic development today. In Unit 12: Object Manipulation, you learn about grippers. You design, build, and test one of your own, as well as evaluate and communicate the attributes of your design.

The concepts of mechanical object manipulation have a variety of real-world applications. If we look at nature, we can see numerous examples of object manipulation (e.g., the way a bird will use its beak to pick up and manipulate seeds or nuts). In STEM Connections, we are presented with a series of questions relating to mechanical object manipulation that mimics the movement of a crab's claw. After completing the Think Phase and Build Phase in Unit 12: Object Manipulation, you will see how object manipulation plays out in the real world.

Unit Objectives

After completing Unit 12: Object Manipulation, you will be able to:

- List methods used in designing robot object manipulators.
- Create rendered animations of mechanisms in Autodesk® Inventor® Professional.
- Apply your knowledge gained in the Unit 12: Object Manipulation.

Unit 13 – Rotating Joints

In Unit: 13 Rotating Joints, you design a rotating joint to attach an existing gripper to a drivetrain from a previous unit. The emphasis is on design process, application of knowledge from previous units, iterating for integration as necessary, and completing a robot to perform in a challenge.

The concepts of rotating joints have a variety of real-world applications. In STEM Connections, we present a series of questions related to rotating joints as used in the moveable rudder on the tail of a small airplane. After completing the Think Phase and Build Phase in Unit 13: Rotating Joint, you will see how object manipulation plays out in the real world.

Unit Objectives

After completing Unit 13: Rotating Joints, you will be able to:

- Determine the number of degrees of freedom in a mechanical system and calculate the gearing needed to lift a load using a rotating joint.
- Analyze the motion of a parallel gripper mechanism in Autodesk® Inventor® Professional.
- Apply the knowledge gained in the Unit 13: Object Manipulation.
- Test the designs of drivetrains, rotating joints, and grippers and improve the designs based on performance reviews.

Unit 14 – Accumulator Design

In Unit 14: Accumulator Design, you learn about the use and design of accumulators. You design your own accumulator, report on your learning and findings, and speculate on design changes and improvements given possible changes in the design challenge.

The concepts behind the accumulator design have many real-world applications. In STEM Connections, we are presented with the design of an automatic tennis ball collector. After completing the Think Phase and Build Phase in Unit 14: Accumulator Design, you will see how those concepts come into play in the real world.

Objectives

After completing Unit 14: Accumulator Design, you will be able to:

- Describe the basic considerations of accumulator design and design a basic mechanism to collect multiples of an object off the floor.
- Create and review a DWF™ file using Autodesk® Inventor® Professional 2009.
- Apply the knowledge gained in the Unit 14: Accumulator Design.
- Improve an accumulator based on test results.

Unit 15 – Linkages

In Unit 15, you learn about linkages: why they are used and how they are designed. You build your own linkage to use with a drivetrain and a gripper from previous units, improving on overall robot design. Design process and findings are also communicated.

The concepts behind linkages have countless real-world applications. In STEM Connections, we pose questions regarding a pair of vise grips that make use of an adjustable four-bar linkage system. After completing the Think and Build Phases, you see how those concepts come into play in the real world.

Unit Objectives

After completing Unit 15: Linkages, you will be able to:

- Describe the primary use for linkages and determine uses for linkages in a robot design.
- Use Dynamic Simulation in Autodesk® Inventor® Professional to analyze four-bar linkage mechanisms.
- Apply the knowledge gained in the Unit 15: Linkages.
- Understand the advantages of linkage designs.

Unit 16 – Bumper and Limit Switch

In Unit 16: Bumper and Limit Switch, you learn about limit switches, their most common uses in robotics, and how to integrate them successfully into a complete robot design. You document and communicate your decision-making and design process.

The concepts behind bumper and limit switches have countless real-world applications. In STEM Connections, we pose questions regarding a robotic lawnmower. After completing the Think and Build phases, you see how those concepts come into play in the real world.

Unit Objectives

After completing this unit, you will be able to:

- Describe the differences between a bumper switch and a limit switch and list some of their uses.
- Use Cable and Harness to add wiring to the bumper switches using Autodesk® Inventor® Professional.
- Integrate limit switches into a robot to increase functionality.
- Explain the usefulness of limit switches and their applications, and generate ideas as to where limit switches can be used to maximize functionality.

Unit 17 – Systems Integration

In Unit 17, you learn about systems integration. You then develop, improve upon, and integrate subsystem designs to create a complete robot to compete in a given challenge. This unit expects students to fully use the design process and seamlessly apply knowledge from prior units. The emphasis is on documentation and presentation, as well as robot performance and evaluation.

The concept of systems integration has countless real-world applications from the smallest nano levels of electronic devices to huge buildings and equipment and transportation designs. For this unit, we have developed STEM Connections related to system integration in a two-passenger research submarine. After completing the Think and Build phases, you see how system integration concepts come into play in the real world.

Unit Objectives

After completing this unit, you will be able to:

- Describe systems integration and apply the concepts of good systems integration to VEX Robotics.
- Integrate various systems into one complete robot.
- Test and evaluate the interactions between various subsystems.