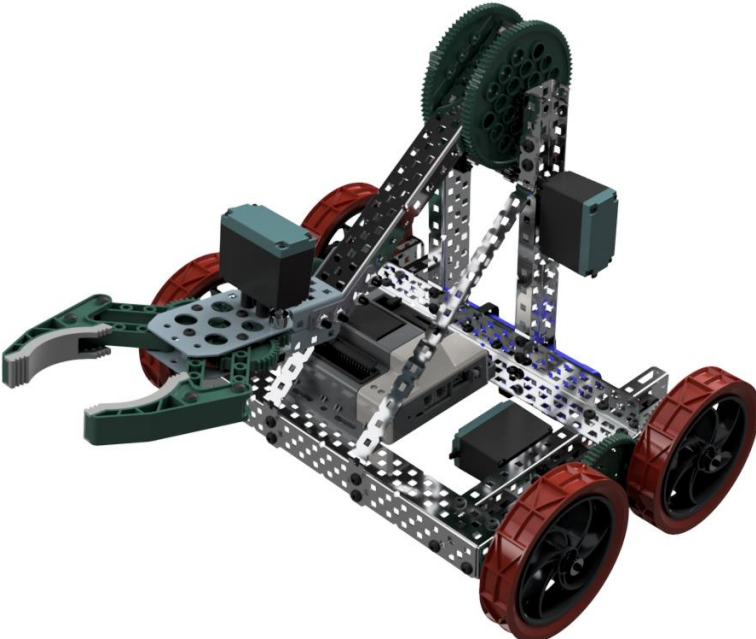


FUSION 360: DESIGN AND CUSTOMIZE A VEX EDR CLAWBOT



## Contents

COURSE OVERVIEW .....	5
DESCRIPTION .....	5
LEARNING OBJECTIVES FOR THE COURSE .....	5
LENGTH OF THE COURSE .....	5
LEVEL .....	5
PREREQUISITE.....	5
COURSE RESOURCES .....	5
LESSONS .....	5
LESSON OVERVIEWS.....	7
LESSON 1: Fusion 360: Foundational Concepts Part 1.....	7
PREREQUISITES.....	7
SCHEDULE.....	7
LESSON 2: Fusion 360: Foundational Concepts Part 2.....	8
PREREQUISITES.....	8
SCHEDULE.....	8
LESSON 3: Assemble the drive mechanism .....	9
PREREQUISITES.....	9
RESOURCES .....	9
SCHEDULE.....	9
INSTRUCTOR NOTES .....	9
COLLABORATION ACTIVITY .....	9
ASSESSMENT GUIDELINES: .....	10
LESSON 4: Assemble the clawbot arm.....	11
PREREQUISITES.....	11
RESOURCES .....	11
SCHEDULE.....	11
INSTRUCTOR NOTES .....	11
COLLABORATION ACTIVITY .....	11
ASSESSMENT GUIDELINES .....	12
LESSON 5: Assemble the claw and gear to the robot .....	13
PREREQUISITES.....	13
RESOURCES .....	13

SCHEDULE.....	13
INSTRUCTOR NOTES .....	13
COLLABORATION ACTIVITY .....	13
ASSESSMENT GUIDELINES: .....	14
LESSON 6: Complete the assembly and review the design.....	15
PREREQUISITES.....	15
RESOURCES .....	15
SCHEDULE.....	15
INSTRUCTOR NOTES .....	15
COLLABORATION ACTIVITY .....	16
ASSESSMENT GUIDELINES: .....	16
LESSON 7: Document the robot design .....	17
PREREQUISITES.....	17
RESOURCES .....	17
SCHEDULE.....	17
INSTRUCTOR NOTES .....	17
COLLABORATION ACTIVITY .....	18
ASSESSMENT GUIDELINES: .....	18
LESSON 8: Rendering and animation.....	19
PREREQUISITES.....	19
RESOURCES .....	19
SCHEDULE.....	19
INSTRUCTOR NOTES .....	19
COLLABORATION ACTIVITY .....	19
ASSESSMENT GUIDELINES: .....	20
LESSON 9: Design a custom robot part.....	21
PREREQUISITES.....	21
RESOURCES .....	21
SCHEDULE.....	21
INSTRUCTOR NOTES .....	21
COLLABORATION ACTIVITY .....	22
ASSESSMENT GUIDELINES: .....	22
LESSON 10: Assemble the custom part .....	23

PREREQUISITES.....	23
RESOURCES .....	23
SCHEDULE.....	23
INSTRUCTOR NOTES .....	23
COLLABORATION ACTIVITY .....	23
ASSESSMENT GUIDELINES: .....	24

## COURSE OVERVIEW

### DESCRIPTION

The course will take the user through the assembly a VEX EDR Clawbot robot using Fusion 360. It will cover all aspects of the use of Fusion 360 including; creating an assembly structure using existing VEX EDR Clawbot robot components, creating assembly and detail drawings, a parts list, rendering the robot design and animations. Users will also learn how to design their own part or assembly to attach to the robot and the steps required to 3D print their designs.

### LEARNING OBJECTIVES FOR THE COURSE

- Complete the Fusion 360: Foundational Concepts course.
- Using Fusion 360, assemble robot components to create the VEX EDR Clawbot.
- Create assembly and detail drawings of your robot.
- Create rendered images of your robot.
- Create animations of an exploded view of your robot.
- Design a custom part or assembly for your robot and 3D print the design.

### LENGTH OF THE COURSE

10 hours

### LEVEL

Intermediate

### PREREQUISITE

Students require an **Autodesk ID** to access Fusion 360 and the Foundational Concepts material.

### COURSE RESOURCES

PDF step by step guides

Learning Videos

Datasets

Quizzes

### LESSONS

- 01 Fusion 360: Foundational Concepts Part 1
- 02 Fusion 360: Foundational Concepts Part 2
- 03 Assemble the drive mechanism
- 04 Assemble the clawbot arm
- 05 Assemble the claw and gear to the robot
- 06 Complete the assembly and review the design
- 07 Document the robot design
- 08 Rendering and animation
- 09 Design a custom robot part

10 Assemble the custom part

## LESSON OVERVIEWS

### LESSON 1: Fusion 360: Foundational Concepts Part 1

This lesson introduces the students to the core concepts behind the file structure and a review of the user interface and navigation.

#### PREREQUISITES

- Autodesk ID

#### SCHEDULE

TIME (MIN)	ACTIVITY
0 - 10	<ul style="list-style-type: none"><li>• Review the course objectives.</li><li>• Students login to Autodesk Design Academy and download the course materials. Alternately, you can download prior to this lesson and make them available on a server location.</li><li>• Students access the Fusion 360: Foundational Concepts Course</li></ul>
10 -- 60	<ul style="list-style-type: none"><li>• Students complete Lessons 1 to 4.</li></ul>

## LESSON 2: Fusion 360: Foundational Concepts Part 2

This lesson introduces the students to modeling and collaboration. Challenge assignments are also provided to measure the student's comprehension of the foundational concepts.

### PREREQUISITES

- Complete Lesson 1: Fusion 360: Foundational Concepts Part 1

### SCHEDULE

TIME (MIN)	ACTIVITY
0 - 5	<ul style="list-style-type: none"><li>• Review the material covered in Lesson 1</li><li>• Students access the Fusion 360: Foundational Concepts Course</li></ul>
5 -- 60	<ul style="list-style-type: none"><li>• Students complete Lessons 5 to 9.</li></ul>



## LESSON 3: Assemble the drive mechanism

This lesson introduces the student to the assembly workflow. A partially completed robot is supplied and the student uses the VEX Guide for Building the Clawbot for reference in assembling the first phase of the robot design.

### PREREQUISITES

- Complete Lesson 2: Fusion 360: Foundational Concepts Part 2

### RESOURCES

PROJECT RESOURCES	INSTRUCTOR	STUDENT
VIDEO	VEX_EDR_LESSON3_1.mp4 VEX_EDR_LESSON3_2.mp4 VEX_EDR_LESSON3_3.mp4	VEX_EDR_LESSON3_1.mp4 VEX_EDR_LESSON3_2.mp4 VEX_EDR_LESSON3_3.mp4
DATASETS	VEX_EDR_LESSON3.f3z	VEX_EDR_LESSON3.f3z
STEP BY STEP GUIDE	VEX_EDR_LESSON3.pdf	VEX_EDR_LESSON3.pdf
INSTRUCTORS GUIDE	VEX_EDR_CLAWBOT_GUIDE.pdf	

### SCHEDULE

TIME (MIN)	STUDENT ACTIVITY
0 - 20	<ul style="list-style-type: none"><li>• Review the material covered in Lesson 2.</li><li>• Create a new project and upload the supplied files.</li><li>• Review the videos for this lesson.</li><li>• Distribute the VEX Guide for Building the Clawbot in digital or paper format. The guide is provided in PDF format with the Datasets.</li></ul>
20 -- 60	<ul style="list-style-type: none"><li>• Students complete the lesson using the video and / or the step by step guide.</li></ul>

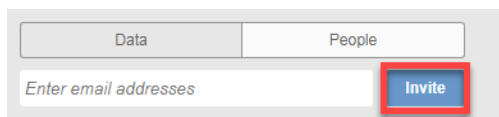
### INSTRUCTOR NOTES

Demonstrate the following:

1. Uploading the files.
2. Opening the partially completed VEX EDR robot.
3. Inserting a component into the design.
4. Review joint origins and how they will be used to assemble the robot.

### COLLABORATION ACTIVITY

At the completion of the lesson, students should invite other students or robot team members to their project.



The image shows a software interface with two tabs: 'Data' and 'People'. Below the tabs is a text input field with the placeholder text 'Enter email addresses'. To the right of the input field is a blue button with the text 'Invite' in white. The button is highlighted with a red rectangular border.

## ASSESSMENT GUIDELINES:

Use the following criteria to assess the students work.

1. **Yes/No:** Did the student create a new project in Fusion 360 and upload the datasets?
2. **Yes/No:** Did the student complete Steps 16 to 17 in the VEX Guide?
3. **Yes/No:** Did the student invite other people to the project?

## LESSON 4: Assemble the clawbot arm

This lesson continues the assembly workflow. The partially completed robot from the previous lesson is used and the student uses the VEX Guide for Building the Clawbot for reference in assembling the second phase of the robot design.

### PREREQUISITES

- Complete Lesson 3: Assemble the drive mechanism.

### RESOURCES

PROJECT RESOURCES	INSTRUCTOR	STUDENT
VIDEO	VEX_EDR_LESSON4_1.mp4 VEX_EDR_LESSON4_2.mp4	VEX_EDR_LESSON4_1.mp4 VEX_EDR_LESSON4_2.mp4
DATASETS	VEX_EDR_LESSON4.f3z	
STEP BY STEP GUIDE	VEX_EDR_LESSON4.pdf	VEX_EDR_LESSON4.pdf
INSTRUCTORS GUIDE	VEX_EDR_CLAWBOT_GUIDE.pdf	

### SCHEDULE

TIME (MIN)	STUDENT ACTIVITY
0 - 20	<ul style="list-style-type: none"><li>• Review the material covered in Lesson 3.</li><li>• Review the videos for this lesson.</li></ul>
20 -- 60	<ul style="list-style-type: none"><li>• Optional: Continue with the design from Lesson 3 or use Save As and rename the design as VEX EDR_LESSON4.</li><li>• Students complete the lesson using the video and / or the step by step guide.</li></ul>

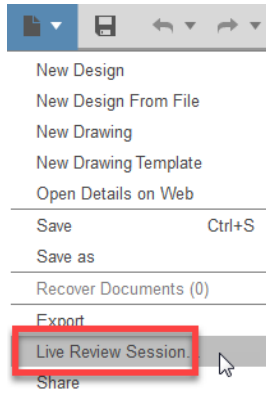
### INSTRUCTOR NOTES

Demonstrate the following:

1. For the students, using the file from the previous lesson or using Save As to rename the design.
2. For the instructor demonstrations, open the supplied file.
3. Review motion links and how they will be used with the claw arm design.

### COLLABORATION ACTIVITY

At the completion of the lesson, students should invite other students to a Live Review session.



## ASSESSMENT GUIDELINES

Use the following criteria to assess the students work.

1. **Yes/No:** Did the student assemble the channel onto the gears in the correct position?
2. **Yes/No:** Did the student complete Steps 18 to 19 in the VEX Guide?
3. **Yes/No:** Did the student invite other people to a Live Review session?

## LESSON 5: Assemble the claw and gear to the robot

This lesson inserts the completed claw arm subassembly into the robot design. The student uses the VEX Guide for Building the Clawbot for reference in assembling the third phase of the robot design.

### PREREQUISITES

- Complete Lesson 4: Assemble the clawbot arm.

### RESOURCES

PROJECT RESOURCES	INSTRUCTOR	STUDENT
VIDEO	VEX_EDR_LESSON5_1.mp4 VEX_EDR_LESSON5_2.mp4 VEX_EDR_LESSON5_3.mp4	VEX_EDR_LESSON5_1.mp4 VEX_EDR_LESSON5_2.mp4 VEX_EDR_LESSON5_3.mp4
DATASETS	VEX_EDR_LESSON5.f3z	
STEP BY STEP GUIDE	VEX_EDR_LESSON5.pdf	VEX_EDR_LESSON5.pdf
INSTRUCTORS GUIDE	VEX_EDR_CLAWBOT_GUIDE.pdf	

### SCHEDULE

TIME (MIN)	STUDENT ACTIVITY
0 - 20	<ul style="list-style-type: none"><li>• Review the material covered in Lesson 4.</li><li>• Review the videos for this lesson.</li></ul>
20 -- 60	<ul style="list-style-type: none"><li>• Optional: Continue with the design from Lesson 4 or use Save As and rename the design VEX_EDR_LESSON5.</li><li>• Students complete the lesson using the video and / or the step by step guide.</li></ul>

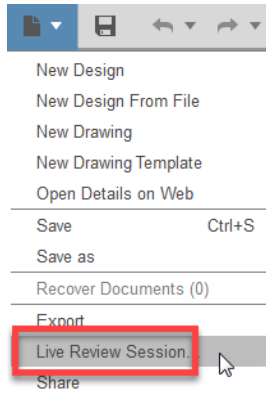
### INSTRUCTOR NOTES

Demonstrate the following:

1. For the students, using the file from the previous lesson or using Save As to rename the design.
2. For the instructor demonstrations, open and review the supplied file.
3. Review motion links.

### COLLABORATION ACTIVITY

At the completion of the lesson, students should invite other students to a Live Review session.



### ASSESSMENT GUIDELINES:

Use the following criteria to assess the students work.

1. **Yes/No:** Did the student successfully create motion links between the two gear assemblies and the main robot?
2. **Yes/No:** Did the student complete Steps 20 to 21 in the VEX Guide?
3. **Yes/No:** Did the student invite other people to a Live Review session?

## LESSON 6: Complete the assembly and review the design

This lesson assembles the completed claw arm subassembly onto the robot design then adds battery straps, Cortex controller, supports and a battery into the design.

### PREREQUISITES

- Complete Lesson 5: Assemble the claw and gear to the robot.

### RESOURCES

PROJECT RESOURCES	INSTRUCTOR	STUDENT
VIDEO	VEX_EDR_LESSON6_1.mp4 VEX_EDR_LESSON6_2.mp4 VEX_EDR_LESSON6_3.mp4	VEX_EDR_LESSON6_1.mp4 VEX_EDR_LESSON6_2.mp4 VEX_EDR_LESSON6_3.mp4
DATASETS	VEX_EDR_LESSON6.f3z	
STEP BY STEP GUIDE	VEX_EDR_LESSON6.pdf	VEX_EDR_LESSON6.pdf
INSTRUCTORS GUIDE	VEX_EDR_CLAWBOT_GUIDE.pdf	

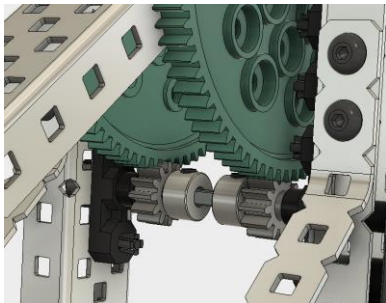
### SCHEDULE

TIME (MIN)	STUDENT ACTIVITY
0 - 20	<ul style="list-style-type: none"><li>• Review the material covered in Lesson 5.</li><li>• Review the videos for this lesson.</li></ul>
20 -- 60	<ul style="list-style-type: none"><li>• Optional: Continue with design from Lesson 5 or use Save As and rename the design VEX_EDR_LESSON6.</li><li>• Students complete the lesson using the video and / or the step by step guide.</li></ul>

### INSTRUCTOR NOTES

Demonstrate the following:

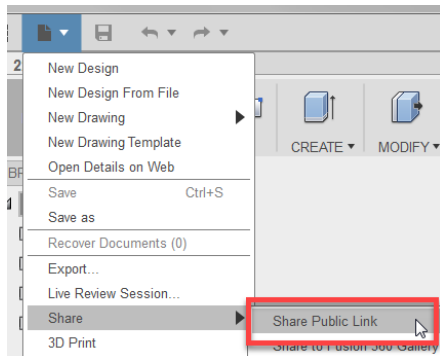
1. For the students, using the file from the previous lesson or using Save As to rename the design.
2. For the instructor demonstrations, open the supplied file.
3. Review VEX gears and gear ratios as it applies to the claw arm and the gear assemblies.



- Review limiting the motion of the claw arm using joint limits.

## COLLABORATION ACTIVITY

At the completion of the lesson, students should use Share > Share Public Link then email the link to other design team members so that can review the current design.



## ASSESSMENT GUIDELINES:

Use the following criteria to assess the students work.

1. **Yes/No:** Did the student successfully create motion links to enable the animation of the claw arm?
2. **Yes/No:** Did the student complete Steps 22 to 27 in the VEX Guide?
3. **Yes/No:** Did the student create a public link and share the link with other students?



## LESSON 7: Document the robot design

This lesson documents the design by creating drawings of the assembly and detail drawings of a robot component. In addition to the drawings, the student adds balloons and a parts list to a claw subassembly drawing.

### PREREQUISITES

- Complete Lesson 6: Complete the assembly and review the design.

### RESOURCES

PROJECT RESOURCES	INSTRUCTOR	STUDENT
VIDEO	VEX_EDR_LESSON7_1.mp4 VEX_EDR_LESSON7_2.mp4 VEX_EDR_LESSON7_3.mp4	VEX_EDR_LESSON7_1.mp4 VEX_EDR_LESSON7_2.mp4 VEX_EDR_LESSON7_3.mp4
DATASETS	VEX_EDR_DRAWING.f3z VEX_EDR_ISO.pdf VEX_EDR_ASME.pdf	VEX_EDR_DRAWING.f3z
STEP BY STEP GUIDE	VEX_EDR_LESSON7.pdf	VEX_EDR_LESSON7.pdf
INSTRUCTORS GUIDE	VEX_EDR_CLAWBOT_GUIDE.pdf	

### SCHEDULE

TIME (MIN)	STUDENT ACTIVITY
0 - 20	<ul style="list-style-type: none"><li>• Review the material covered in Lesson 6.</li><li>• Upload the supplied file.</li><li>• Review the videos for this lesson.</li></ul>
20 -- 60	<ul style="list-style-type: none"><li>• Students complete the lesson using the video and / or the step by step guide.</li></ul>

### INSTRUCTOR NOTES

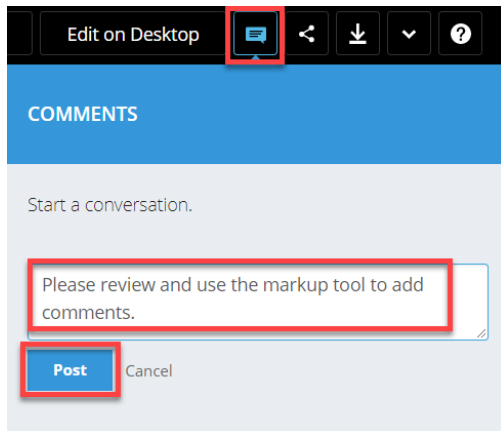
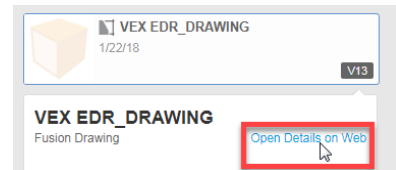
Demonstrate the following:

1. Open the supplied file then create a drawing from an existing design.
2. Saving a drawing and review its location in the project data panel.
3. Selecting the drawing standards for the design and provide an overview of key requirements such as number of required views, dimensioning to visible lines and using the minimum number of dimensions on a drawing.
4. The 2 supplied PDF's can be reviewed with students. One PDF uses ISO standards and the other uses ASME.

## COLLABORATION ACTIVITY

At the completion of the lesson, students should show the data panel, locate the drawing then click the version number, and then click Open Details on the Web.

Click Comments then add a comment to start a conversation with other team members. The comments should ask the team to review the drawing and use the markup tool to add comments.



## ASSESSMENT GUIDELINES:

Use the following criteria to assess the students work.

1. **Yes/No:** Did the student complete the three drawings and output as a PDF?
2. **Yes/No:** Did the student successfully renumber the parts list?
3. **Yes/No:** Did the student start a web-based conversation with other students asking them to review and markup the drawing?

## LESSON 8: Rendering and animation

This lesson uses the Render and Animation workspaces to create photorealistic images of the robot and an animation of an exploded assembly.

### PREREQUISITES

- Complete Lesson 7: Document the robot design.

### RESOURCES

PROJECT RESOURCES	INSTRUCTOR	STUDENT
VIDEO	VEX_EDR_LESSON8_1.mp4 VEX_EDR_LESSON8_2.mp4 VEX_EDR_LESSON8_3.mp4	VEX_EDR_LESSON8_1.mp4 VEX_EDR_LESSON8_2.mp4 VEX_EDR_LESSON8_3.mp4
DATASETS	VEX_EDR_RENDER.f3z Decal\FusionImage.png M63_ANIMATE.f3d M63_ANIMATE_COMPLETE.f3d	VEX_EDR_RENDER.f3z Decal\FusionImage.png M63_ANIMATE.f3d
PDF	VEX_EDR_LESSON8.pdf	VEX_EDR_LESSON8.pdf
INSTRUCTORS GUIDE	VEX_EDR_CLAWBOT_GUIDE.pdf	

### SCHEDULE

TIME (MIN)	STUDENT ACTIVITY
0 - 20	<ul style="list-style-type: none"><li>• Review the material covered in Lesson 7.</li><li>• Upload the supplied file.</li><li>• Review the videos for this lesson.</li></ul>
20 -- 60	<ul style="list-style-type: none"><li>• Students complete the lesson using the video and / or the step by step guide.</li></ul>

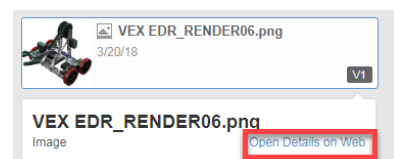
### INSTRUCTOR NOTES

Demonstrate and / or discuss the following:

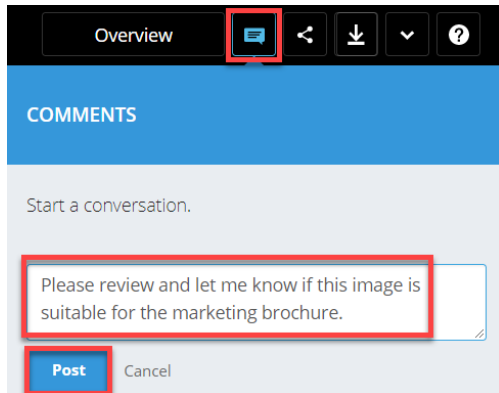
1. In the Scene Settings dialog: Background (Solid Color and Environment), ground plane and aspect ratio.
2. In-canvas render versus Cloud rendering versus local.
3. Saving a rendered image to a project and a folder.

### COLLABORATION ACTIVITY

At the completion of the lesson, students should show the data panel, locate the rendered image then click the version number, and then click Open Details on the Web.



Click Comments then add a comment to start a conversation with other team members. The comments should ask the team to review the image and let you know if it is suitable for a marketing brochure.



#### ASSESSMENT GUIDELINES:

Use the following criteria to assess the students work.

1. **Yes/No:** Did the student create a series of rendered images?
2. **Yes/No:** Did the student create an AVI of the exploded motor assembly?
3. **Yes/No:** Did the student start a web-based conversation with other students asking them to review and approve the rendered images?

## LESSON 9: Design a custom robot part

Design and model a custom phone case that will be attached to the robot for video capturing during competition practice.

### PREREQUISITES

- Complete Lesson 8: Rendering and animation.

### RESOURCES

PROJECT RESOURCES	INSTRUCTOR	STUDENT
VIDEO	VEX_EDR_LESSON9_1.mp4 VEX_EDR_LESSON9_2.mp4 VEX_EDR_LESSON9_3.mp4	VEX_EDR_LESSON9_1.mp4 VEX_EDR_LESSON9_2.mp4 VEX_EDR_LESSON9_3.mp4
DATASETS	VEX_EDR_CASE.f3z VEX_EDR_CASE_COMPLETE.f3z PHONE.f3d PHONE_COMPLETE.f3d PHONE_LIBRARY\various files	VEX_EDR_CASE.f3z PHONE.f3d PHONE_LIBRARY\various files
PDF	VEX_EDR_LESSON9.pdf	VEX_EDR_LESSON9.pdf
QUIZ	VEX_EDR_LESSON9_QUIZ_ANSWERS.pdf	VEX_EDR_LESSON9_QUIZ.pdf
INSTRUCTORS GUIDE	VEX_EDR_CLAWBOT_GUIDE.pdf	

### SCHEDULE

TIME (MIN)	STUDENT ACTIVITY
0 - 20	<ul style="list-style-type: none"><li>• Upload the supplied files.</li><li>• Review the videos for this lesson.</li><li>• Review the phone models available in the PHONE_LIBRARY folder.</li></ul>
20 -- 60	<ul style="list-style-type: none"><li>• Students complete the lesson using the video and / or the step by step guide.</li></ul>

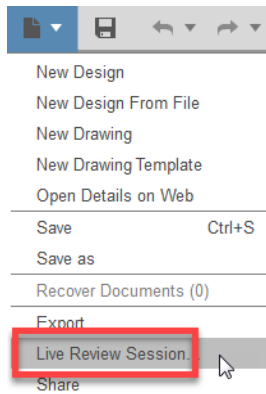
### INSTRUCTOR NOTES

Demonstrate or discuss the following:

1. Review the design process and set design criteria for the phone case.
2. How to gather the design data required for the case. For example, dimensions for bolt hole placement.
3. Review the phone models available in the PHONE\_LIBRARY folder. These models can be used in place of the phone model used in the videos or as a challenge exercise.

## COLLABORATION ACTIVITY

At the completion of the lesson, students should invite other students to a Live Review session.



## ASSESSMENT GUIDELINES:

Use the following criteria to assess the students work.

1. **Yes/No:** Did the student create the bolt hole features on the case?
2. **Yes/No:** Did the student create an opening on the case to match the camera lens?
3. **Yes/No:** Did the student invite other people to a Live Review session?

## LESSON 10: Assemble the custom part

In Fusion 360, assemble the phone case assembly onto the robot then create drawings, rendered images and an animation of the assembly process.

STL files are created and uploaded to a 3D printer. The physical prototypes are assembled onto the robot and the design is tested in a practise game situation.

### PREREQUISITES

- Complete Lesson 9: Design a custom robot part.

### RESOURCES

PROJECT RESOURCES	INSTRUCTOR	STUDENT
VIDEO	VEX_EDR_LESSON10.mp4	VEX_EDR_LESSON10.mp4
DATASETS	VEX_EDR_CASE_COMPLETE.f3z	
PDF	VEX_EDR_LESSON10.pdf	VEX_EDR_LESSON10.pdf
QUIZ	VEX_EDR_LESSON10_QUIZ_ANSWERS.pdf	VEX_EDR_LESSON10_QUIZ.pdf
INSTRUCTORS GUIDE	VEX_EDR_CLAWBOT_GUIDE.pdf	

### SCHEDULE

TIME (MIN)	STUDENT ACTIVITY
0 - 20	<ul style="list-style-type: none"><li>• Review the material covered in Lesson 9.</li><li>• Review the video for this lesson.</li></ul>
20 -- 60	<ul style="list-style-type: none"><li>• Continue with the design from Lesson 9.</li><li>• Students complete the lesson using the video and / or the step by step guide.</li></ul>

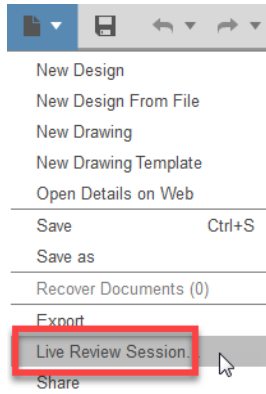
### INSTRUCTOR NOTES

Demonstrate or discuss the following:

1. Review the 3D print process.
2. Discuss how to test and provide feedback on the phone case design.

### COLLABORATION ACTIVITY

At the completion of the lesson, students should invite other students to a Live Review session.



### ASSESSMENT GUIDELINES:

Use the following criteria to assess the students work.

1. **Yes/No:** Did the student complete the assembly, drawing, rendering and animation tasks in Fusion 360?
2. **Yes/No:** Did the student create a physical model of the phone case and take part in the testing of the prototype?
3. **Yes/No:** Did the student invite other people to a Live Review session?