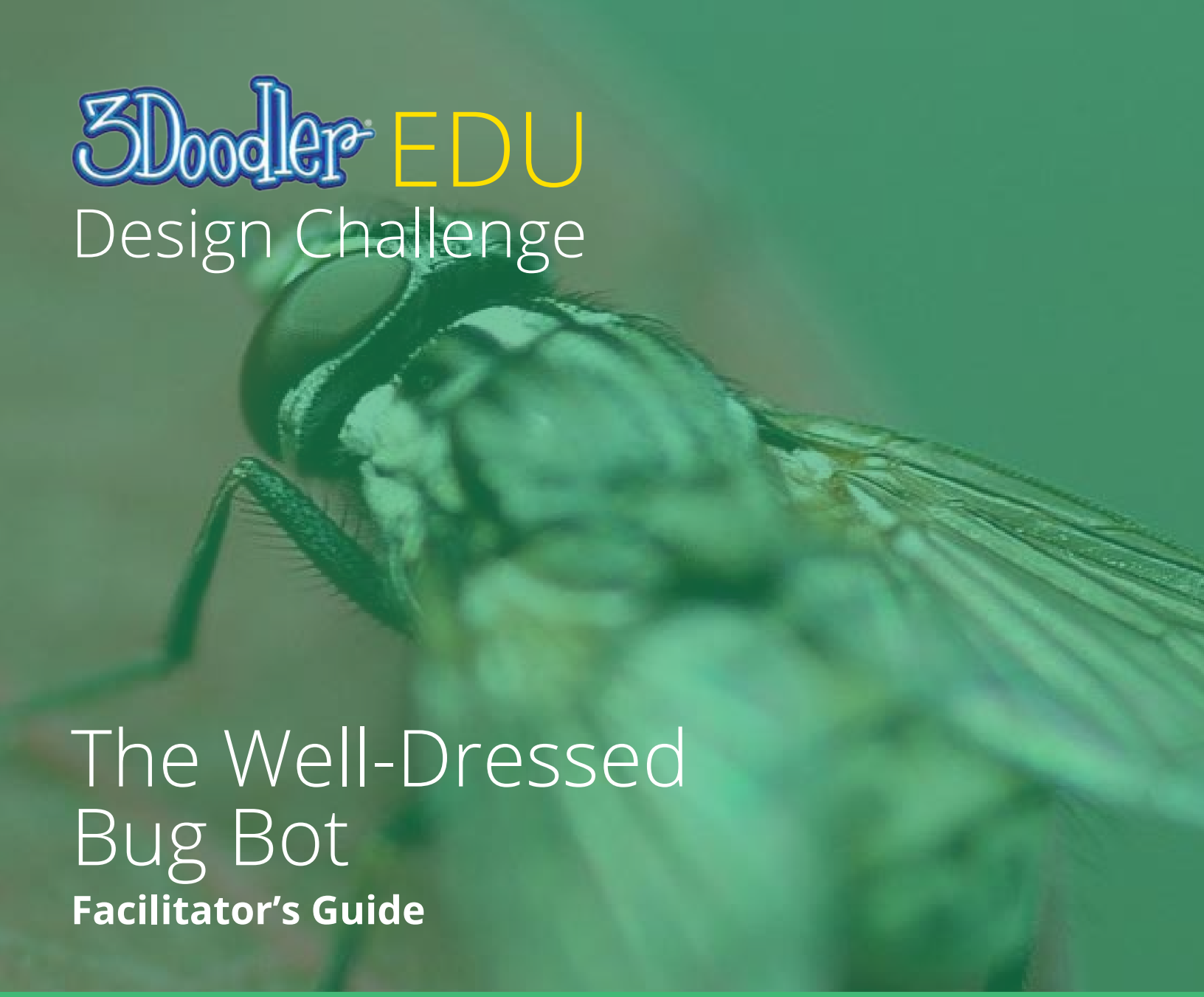


3Doodler EDU

Design Challenge

The Well-Dressed Bug Bot

Facilitator's Guide

The Challenge

After studying the natural design of insects, create an exoskeleton for your bug bot using the 3Doodler pen and plastic strands.

Overview

Total Time: 200 minutes (4 Class Periods)

This challenge asks participants to look at the design of insects from a physical, reproductive, survival and social viewpoint. This challenge also provides an opportunity for participants to make a basic robot using a simple circuit and materials. This is a great way to connect the study of insect biology and habitat with observation skills, technology and making.

Challenge Background

Take It Further
Use what you've learned in this Design Challenge to create an exoskeleton for a robot competition or to protect and camouflage a pre-made drone.

Fig.1

Fig.2

Insects make up two-thirds of the organisms on planet earth. They are thought to be the first creatures to leave the oceans for the land over 400 million years ago. All insects have similar body features, including the following: a pair of antennae, three pairs of segmented legs, compound eyes and a protective exoskeleton that covers their head, thorax and abdomen. But they come in a range of species, determined by location, color, size, whether it has wings, type of food source and overall mechanics. Insects are not only researched for their biology. Insects are studied for ways they interact as a collective, like ants and bees, for the use in technological innovation, such as drones. Their mechanics are studied for scientific exploration in extreme environments like space. How does a bug's exoskeleton determine its survival?

Materials & Tools

Before You Start Doodling
We recommend using a DoodlePad or clear tape placed over paper as a foundation to keep your Doodles in place and so that you can peel them off with ease.

A. 3Doodler Pens and Plastic Strands of various colors (one per student, or have students work in pairs or small groups)
B. Tools (from your 3Doodler box) plus needle-nose pliers or scissors for snipping plastic ends
C. Clear plastic tape or DoodlePad for Doodling foundation
D. Paper for Doodling foundation and extra sketching/note-taking space
E. Drawing utensils (markers, pens or pencils)
F. Camera or video recording device to document the Challenge and results
G. Supplies for making bug bots (listed on following page)

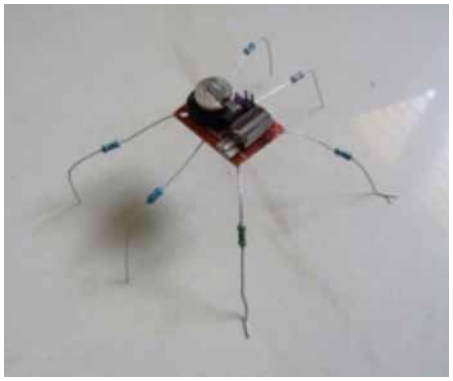
Level: Easy

Fig.3

Materials:

- Two 12" strands of wire
- One 3v motor
- One AA battery
- Two pieces of foam board (or more if desired)
- Toothbrush head
- Hot glue gun

Level: Complex



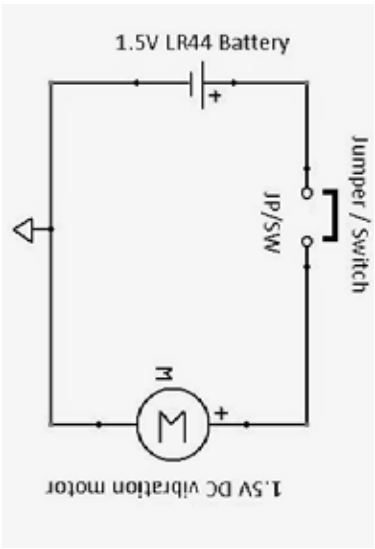


Fig.4

Materials:

- Vibration motor used in mobile phones
- One LR 44 1.5V battery
- R44 battery holder
- Jumper pin/small switch
- Vero board/general purpose PCB
- Resistors of any value to make the legs – 6pcs
- Soldering iron/kit to mount and connect all on PCB

Challenge Organization

Challenge Documentation
Take photos & videos of your process using a camera. Document what to do and what not to do. Share your experience with the online community using #3DoodlerEDU!

Challenges are organized into 50-minute periods so they can fit into a traditional classroom structure, or be combined into a single workshop with breaks in between activities. This Challenge is designed to have participants work in short sprints to quickly explore the concepts.

Class 1:Investigate

Total Time: 50 min

Investigate: (50 min.)

What are the features of an insect? How does the exoskeleton (color, shape, size) contribute to its survival, including mating, camouflage, and communication?

Step 1: Investigate how insects are designed. From your investigation, identify the types of qualities the insects you are building will have.

Step 2: Make notes of the design features your team would like to include, keeping in mind the insect's color, shape and size of antennae, legs and/or wings, compound eyes and the exoskeleton to cover the head, thorax and abdomen.

Step 3: Consider the following: will your bug bot be similar to an existing bug, or will you design a completely new species? Make sure that you can back up your design with facts found during the investigation, as this will count towards your final presentation.

Facilitator's Notes
In Class 1, participants will investigate the world of insects. This can be tied into a biology or robotics curriculum. Have participants observe insects in the environment around them and look up additional information about their family, genus and species.

Class 2: Design & Plan, Present & Re-Design

Total Time: 50 min

Design & Plan: (25 min.)

Remember to Snip Those Ends
We recommend pliers or scissors for snipping plastic ends. Make sure to keep your plastic ends clean to prevent clogs and jams. Snip plastic after removing it from the 3Doodler pen to make sure it's clean for the next time.

Step 1: From your investigation on insect design, draw how your bug will look, noting all of the insect's features. Consider how the exoskeleton will work with the function of the bug bot body.

Step 2: Practice using the 3Doodler and strands to try out various building techniques and designs.

Step 3: Plan for the colors that will be used for all of the bug's features. Consider the order in which the parts will be assembled and how they will attach.

Facilitator's Notes
In Class 2, participants will go through two major activities: 1) design and plan and 2) present and redesign. It's important to leave time to incorporate feedback into their final design. Make sure participants review how the circuit works during Class 2.

Present & Redesign: (25 min.)

Step 1: Pair with another team to show and explain your design ideas. Listen to each other's questions and feedback as you consider how to improve your initial designs.

Step 2: Go back to your stations and incorporate any feedback necessary to tweak your design before you begin to build with the 3Doodler.

Classes 3 & 4: Build, Present & Reflect

Total Time: 100 min.

Build (80 min.)

Step 1: Assemble the main components of the bug bot, which includes all wires, batteries, brushes and motor.

Step 2: Test the bug bot to make sure that it vibrates before attaching the other body parts.

Step 3: Begin creating the exoskeleton, legs, antennae, wings and eyes.

Step 4: Assemble all of the parts together. Make sure that the battery can be easily removed. (This may mean that the exoskeleton can be attached with a clip or using FLEXY strands.) Use the 3Doodler pen to attach the plastic strand components by warming up the metal tip and welding them together.

Step 5: Attach any other body parts using an hot glue gun or duct tape.

Step 6: Test the bug bot to make sure that it moves once fully assembled.

Facilitator's Notes

In Classes 3 & 4 participants will need both sessions to build their bug bot. This could be conducted on the same day or broken up into two sessions. If needed, feel free to add a 5th class to round out the week to cover circuits or to extend any part of the investigation, design or build phases.

Present & Reflect: (20 min.)

Now it's time to present your bug bot. Take 5 minutes to prepare your presentation.

Bug Bots will be evaluated on the following criteria:

- Application of your insect investigation on the design of your bug, including how you named your bug and which family of insects has inspired it.
- Description of how the bug's features help with mating, camouflage and communication.
- Demonstration of how your bug bot moves and how your team created the overall design.

More Information:

For further information and inspiration about insecet design, visit:

- http://www.backyardnature.net/bugbody.htm

For further information and inspiration about insecet biomimetrics, visit:

- http://goo.gl/czzkD0

For further information and inspiration about insecet design, visit:

- http://goo.gl/TU97hW

Images:

Cover Page: http://www.public-domain-image.com/animals/insects/fly/slides/fly-insect.jpg

Fig.1: https://c1.staticflickr.com/3/2050/1585685158_d82b088cac_b.jpg

Fig. 2: https://goo.gl/ZgwgSO

Fig. 3: http://www.redtedart.com/wp-content/uploads/2011/11/mini-robot-materials.jpg

Fig. 4:http://www.instructables.com/id/Make-a-very-simple-insect-robot-toy/?ALLSTEPS#intro