Background:
My thinking about this project was to study an engineering model to understand a scientific model; something physics teachers will appreciate if they are to “cover the content”. Using a simple engineering “tool” like the bristlebot opens up most of the scientific models that are part of the traditional physics curriculum (more on that later). Because this little bot is very simple to build, it requires little precious time. Because this little bot is very fun to watch, it is a natural “hook” for getting students engaged with both physics and engineering. Below is a lesson plan for an introductory unit on motion. With little modification, a teacher can use this to study distance/displacement, vectors/scalars, speed/velocity. As I started thinking about this as a design challenge where the students get the bots to have the greatest displacement in an arbitrary time period (10 seconds in my plan), I realized that the random chaotic nature of the bot resembles the electron’s “drunkard walk”. With no modification of this initial, short build, it requires little imagination to see how this bot can be used as a scientific model for current (one bot=one Coulomb), heat (kinetic theory of temperature), and atomic structure (dip the bot in some paint and see the patterns it traces). I have only written the lesson for displacement as a way to demonstrate how this little toy can help us understand physics and engineering.

I highly recommend that the instructor build one first to gauge the time frame for the initial build. My first prototype took a lot longer than I thought it would because the motor would not stick to the tape. This little lesson in materials science reminds me that sometimes just the type of tape you use can have an giant impact on the project and possibly very frustrated students.

Challenge: Build your Bristle Bots so that they have the largest displacement in a 10 second time period

Materials per group:
Stop watch
toothbrush
pager motor
1.5-3V watch battery
double sided tape (make sure it sticks to motor and toothbrush)
meter sticks
random objects for obstacles

Physics Learning Objectives:
distance/displacement
vector/scalar
speed/velocity

Engineering Objectives:
Design-students create their own obstacle course
Analysis-students have to observe how the bots move so that they can optimize displacement. Models-An engineering model is used to understand a scientific model.

Build and observe: 10-15 minutes

Data:
After playing and observing the bots for several minutes, come up with a way to have your bot have the greatest displacement in a 10 second time period. You may not touch the bot once it is in motion, unless it is going to fall off the table.

For each new timed trial, record the displacement and observations in your engineering journal.

Wrap-up:
use this activity as a starting off point to talk about distance versus displacement, vectors versus scalars and average speed versus average velocity.

Assessment:
1. Did your bristlebot have a constant speed? Explain and use examples from your observations and contest.

2. Imagine that the bristlebot has been dipped in paint and is allowed to “paint” on a piece of paper. How would you calculate the bristlebots average speed from painting on the paper for 10 seconds?

3. Using the same scenario as described above, how could you calculate the average velocity of the bristlebot after 10 seconds?

Resources:

http://www.makershed.com/Build_your_own_scuttling_BrushBot_p/msbb.htm