Aircraft Propeller Revolutions per Minute

Subject Area(s) Introduction to Engineering

Associated Unit None

Associated Lesson None

Activity Title Aircraft Propeller Revolutions per Minute

Header Insert image 1 here, right justified to wrap

Image 1
ADA Description: Students Performing Experiment
Caption: Image 1: Students Recording Data
Image file name: students.jpg
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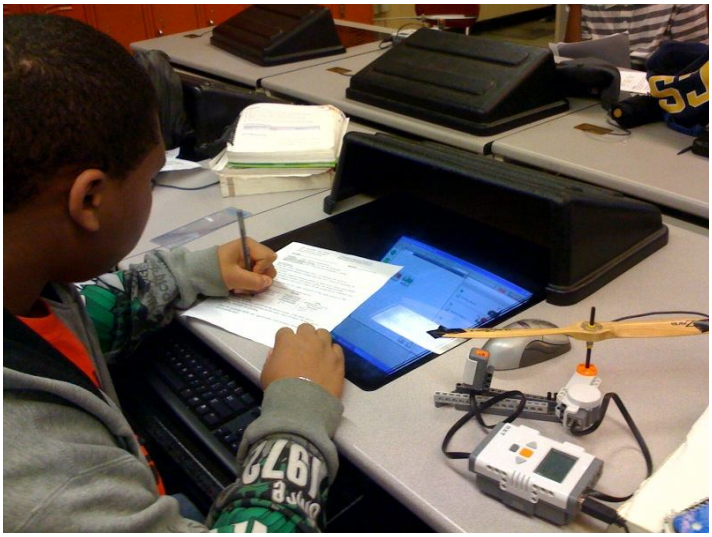


Grade Level 11 (9-12)

Activity Dependency None

Time Required
-45 minutes to build the propeller test rig with teacher assistance and program the NXT brick.
-45 minutes to perform calculations and measurements. Interpretation of results (see worksheet attachment) can be assigned as homework or started in class if time permits.

Group Size

Three students

Expendable Cost per Group US $3-4 (assuming school has NXT and LEGO kits)

Summary

Each group of students will construct a test rig for measuring the RPM (Revolutions per Minute) of a model aircraft (scaled) propeller. The test rig consists of a LEGO NXT Brick, NXT Motor and NXT Light sensor. The propeller is mounted on the motor and the students will measure the time elapsed between propeller blades passing over the light sensor. Two or three bladed propellers can be used.

Engineering Connection

Students will understand the basics of building a test rig to solve a specific problem. They will also learn about data collection and interpretation.

Engineering Category

Relates math and physics concept to engineering.

Keywords

propeller, revolution, RPM, blade, thrust, LEGO, experiment

Educational Standards

- New York Science (Physics 9-12): Standard 2
- New York Science (Physics 9-12): Standard 1
- New York Math (9-12): Measurement Strand

Pre-Requisite Knowledge

Fractions
Square Root

Learning Objectives

After this activity, students should have a basic understanding of how testing is done in an Engineering enterprise. They will be able to collect and interpret data.

Materials List

Each group needs:

- One complete LEGO Mindstorm NXT kit
- Computer with NXT 2.0 software installed

- A black, 10-12in diameter, two blade aircraft model propeller. If no black propellers are found, black tape should be placed on the underside of the propeller.
- A three blade propeller if the activity extension is performed. See the references for vendor link.
- Calculator
- Ruler
- Narrow Scotch or Electrical Tape

Introduction/Motivation

Although most likely you have flown in big jets, a lot of airplanes, big and small, still use propellers to move forward through the air. A propeller is in essence a big fan that blows air backwards such that the airplane can move forward. You felt the air move behind a regular desktop fan. A propeller does just that, but has a lot more “kick”!

Today we are going to test the performance of an aircraft engine by measuring the propeller RPM (Revolutions Per Minute).

Our “engine” will actually be a Lego NXT motor and we will use a Lego light sensor to determine the rotational speed of the propeller. The light sensor will sense a drop in ambient light every time a propeller blade passes over it. The light intensity as a function of time will be plotted for us by the NXT Data Logging software. We will test two-bladed and three blade propellers.

IMAGE Insert Figure 1 here, centered

Image 2
ADA Description: Propeller
Caption: Image 2: Aircraft Four Bladed Propeller
Image file name: Airforce_Museum_Berlin-Gatow_17.JPG

Vocabulary/Definitions

Word	Definition
propeller	Two, three or four rotating wings mounted on a hub connected to an aircraft engine. A propeller moves an aircraft forward by generating thrust.
RPM	Revolutions per Minute. A standard of measuring propeller rotational speed.
Blade	A small wing. A propeller can have two, three or four blades mounted on a central hub.
test rig	A custom-built piece of equipment for testing a newly designed device.

Procedure

Before the Activity

- Teacher should build a test rig and run the experiment on her own.
- Before class, tape, Lego kits, calculators, and computers should be made available to each group.
- Bag of LEGO parts need to be placed in an accessible location for the entire class.(If kits are used….)
- Make sure NXT bricks have power and their memory is cleared, with NXT2.0 Firmware uploaded.

With the Students

1. Construction Phase:

   Assist the student groups in building the setup in Figure 1, by following the steps. The Lego axle sleeve is wrapped in tape in order to fit inside the propeller hub snugly.

IMAGE Insert Figure 1 here, centered

STEP 1

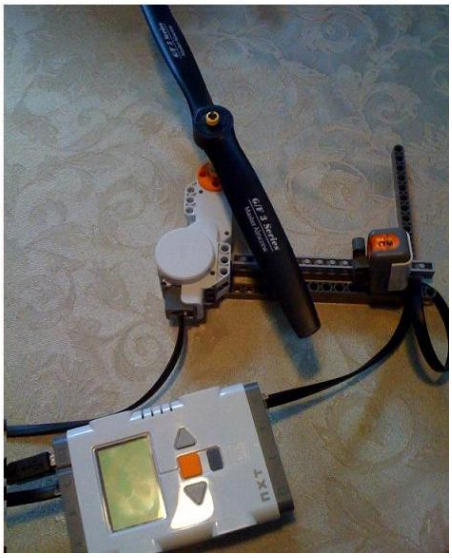
STEP 2

STEP 3

STEP 4

STEP 5

STEP 6



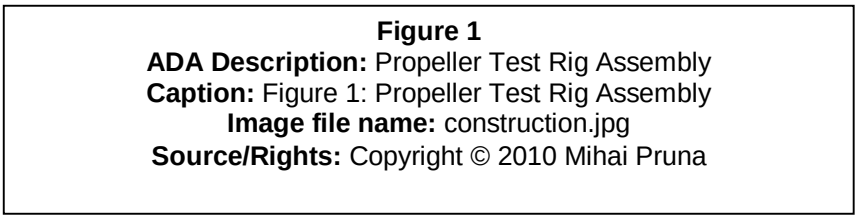


Figure 1
ADA Description: Propeller Test Rig Assembly
Caption: Figure 1: Propeller Test Rig Assembly
Image file name: construction.jpg

2. Programming Phase

Create the simple two-block program outlined in Figure 2.The first block reads data in the NXT Data Logging module. The second spins the propeller. Use the same settings as in the picture, for now.

IMAGE Insert Figure 2 here, centered

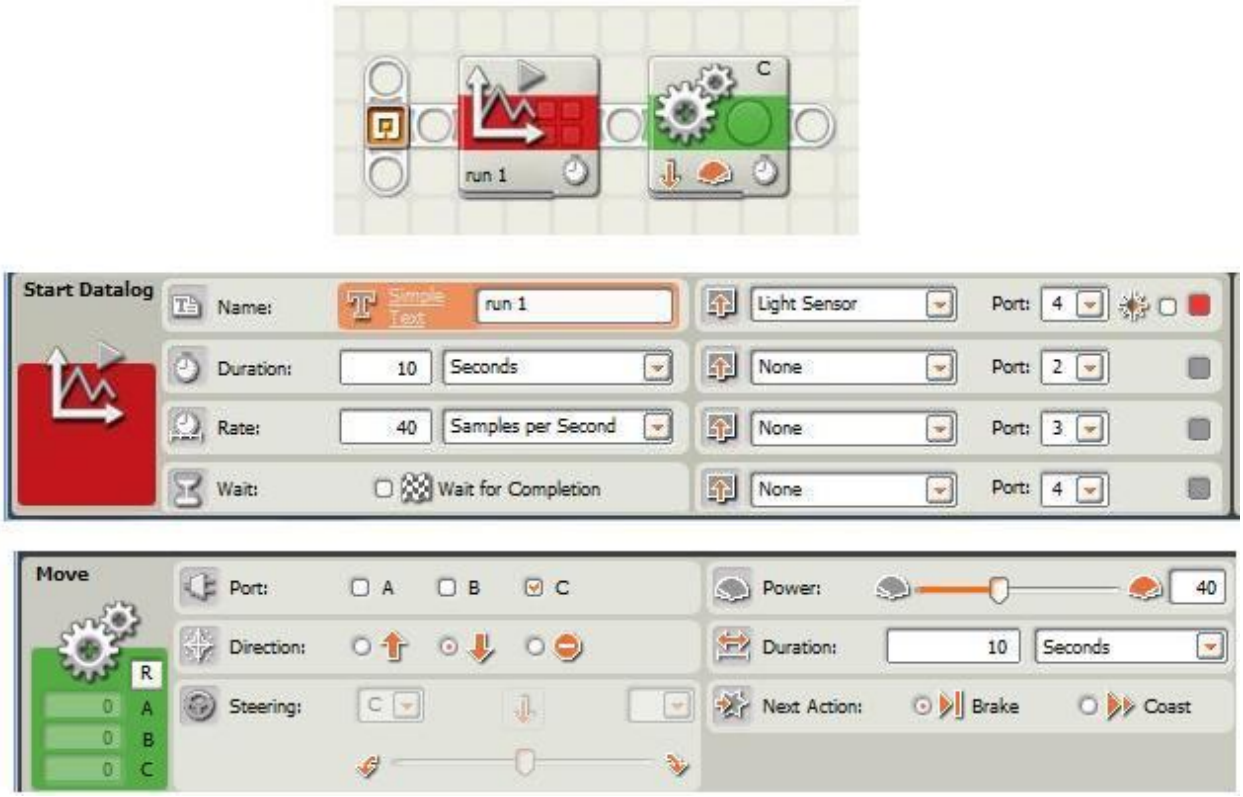


Figure 2
ADA Description: NXT Program Structure
Caption: Figure 2: The Programming Blocks
Image file name: NXT programming.jpg
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3. Data Collection Phase

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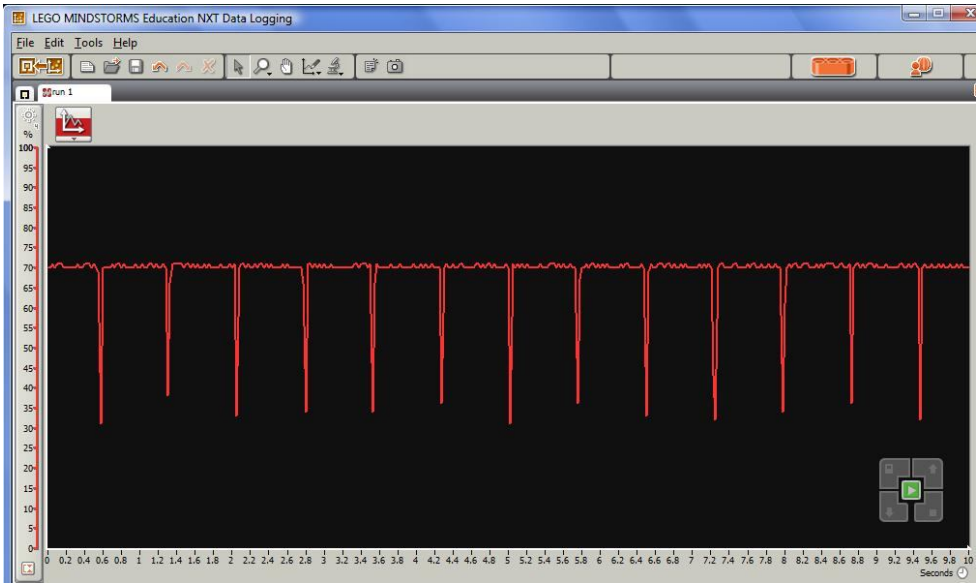

Figure 3
ADA Description: Data Example
Caption: Figure 3: Data Screen Cap
Image file name: data.jpg
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Record the time elapsed between spikes in light level. Since each blade of the two bladed propeller will cause a spike, the time (seconds) between three spikes is the time it takes for the propeller to complete one full revolution.
Perform the experiment three times, changing the position of the light sensor on the horizontal Lego beam by placing it at different holes. Have the students clear the plot from the Mindstorms data logging module between experiments. For every position, the students should measure the horizontal distance between the light sensor and the propeller hub with a ruler.
Have the students fill in the first two columns on the results and analysis worksheet.

4. Calculation Phase

In order to calculate the number of revolutions per minute (RPM), 60 seconds is divided by the time for one revolution. Have the students fill in the last column of the worksheet and answer the inquiry question.

Attachments
Results_and_Analysis_Questions_Worksheet.doc
Results_and_Analysis_Questions_Worksheet.pdf

Safety Issues
Safety goggles should be worn by students operating the experiment.

Troubleshooting Tips
If program cannot be uploaded, erase all data from the brick's memory using the NXT software.
If light level plot is unintelligible, make sure the propeller surface is as close to the light sensor as possible, but not touching while the prop is spinning.

Investigating Questions
None

Assessment

Pre-Activity Assessment
None

Activity Embedded Assessment
None

Post-Activity Assessment
Ask students to fill in the Results and Analysis Worksheet, listed in the attachments section.

Activity Extensions

None

Activity Scaling
Three bladed propeller: Repeat the experiment with a three bladed propeller instead of a two bladed one. Have the students figure out on their own how to calculate the duration of one full rotation from the data plot.

Additional Multimedia Support
None

References

http://masterairscrew.com/

http://www.emsc.nysed.gov/ciai/mst/sci/ls

http://cache.lego.com/downloads/education/9797_LME_UserGuide_US_low.pdf

Other

None

Redirect URL

http://gk12.poly.edu/amps/

Owner

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