FLIGHT DESIGN AND MODELLING ACTIVITY

YEAR 4

In this activity, students will:

1. Explore aerospace and STEM concepts and principles associated with flight (including forces associated with flight).
2. Using engineering design processes, design and build a paper plane.
3. Gather data on the distances and times travelled by the plane.
4. Collect, organise, record, and interpret the data collected.
5. Draw conclusions regarding flight times and distances, noting how plane design and plane launching factors impact on times and distances.
6. Develop a model for determining a winning plane, given time and distance data.
7. Prepare a class report to present to peers on points 5 and 6.

Prerequisite tool use

Students will be using a stopwatch to time their flights, and tape measure to measure flight distance. Familiarity with stopwatches as well as how to operate them is needed. If the children are unfamiliar with these tools, please see if they can be familiarised with these before the activity.

Materials

- Combined Teaching Notes / Student Workbook
- Student Workbook (1 per student)
- QUT supplied A4 paper (1 sheet per student and 1 sheet per group for plane designs)

- Pencil, rubber and ruler – student supplied
- Stop watches and tape measures
- QUT supplied DVD containing:
  - Engineering Model
  - Boeing *787 Flight Video Take-off and Landing HD.mp4* video clip
  - Record breaking paper plane flight video clips featuring Takuo Toda

Organisation of student work

Students will record their learning and results in the student workbooks provided by QUT. These will be collected by QUT at the end of the activity.

Class Time: To be determined

Additional Teacher Information on Flight

- QANTAS Museum
- Introduction to Flight by Tony Mander 2004 (QUT to provide copies of pages 20-29)
- The Aerodynamics of Flight
- *How things fly* Smithsonian National Air and Space Museum
- A good demonstration to show how the air flows over an aeroplane wing.
- Nosedive
- Nasa Kids' website
- Takuo Toda Article

Technology	Science	Maths
Design and Technology (ACARA) **Knowledge and Understanding** • Recognise the role of people in design and technologies occupations and explore factors, including sustainability that impact on the design of products, services and environments to meet community needs (ACTDEK010) **Processes and Production Skills** • Generate, develop, and communicate design ideas and decisions using appropriate technical terms and graphical representation techniques (ACTDEP015)	**Physical Science (ACARA)** • Forces can be exerted by one object on another through direct contact or from a distance (ACSSU076) **Elaborations (C2C)** • Understand that there are different forces • Understand that forces act on objects in a variety of ways including in pairs • Understand the action of forces such as push, pull and friction • Understand how the forces of push and pull act on everyday objects • Understand that the pulling force of the Earth is a non-contact pulling force that acts on objects	**Measurement and Geometry (ACARA)** *Using units of measurement* • Use scaled instruments to measure and compare lengths, masses, capacities and temperatures (ACMMG084) • Convert between units of time and calculate duration (ACMMG085) *Location and transformation* • Create symmetrical patterns, pictures and shapes with and without digital technology (ACMMG091) *Shape* • Compare and describe two dimensional shapes that result from combining and splitting common shapes, with and without the use of digital technologies (ACMMG088) **Elaborations (C2C)** • Organise and measure the duration of events • Explore concepts of angles, symmetry and time in a variety of engaging and real-world contexts • Consolidate/extend understanding of combining and splitting 2D shapes

ACTIVITY OVERVIEW

1. Inform students that today they will be investigating flight and will do so through designing and testing paper planes. Students will experiment with paper plane designs and collect data on the time and distance their (group) paper planes fly.

2. In sum, students will:
   (a) Be introduced to a simple *Engineering Design Model* and learn how it will help them complete the activity.
   (b) Run Individual design & test activity
      - Individually *design and create a paper plane* from A4 paper with the aim of making it travel for a long distance in a straight-line path and stay in the air for as long as possible (fair test rules will be discussed and it will be discussed that if the plane doesn't fly in a straight line path, it is counted as a "scratched" flight and recorded as "scratched" for that particular test).
      - Individually test out the plane (preferably in an indoor environment to negate effects of wind). This will be a test-run carried out in groups of two by all students at the end of the individual exercise.
   (c) Run Group design & test activity
      - As a group, students will identify *factors that can cause variation in the distance and time* travelled. (The students might not know what the term, *variation*, means so they can be questioned on this. Causes of variation can include test conditions, angle of release, amount of thrust given etc)

- As a group, students will discuss and compare the performance of their individual flights, noting the variation in the data.
- As a group, students will learn about the concept of force and the four forces associated with flight (lift, thrust, drag, weight).
- As a group, students will design and create a *group plane* that will capitalise on the design strengths of each plane. In the Workbook, collect and record data for times and distances for 3 *test flights of the group plane* in the designated tables.
- *As a group,* students will *test* their plane (preferably in an indoor environment to negate effects of wind) by measuring the distance the plane travelled (in straight-line path) in metres and centimetres using tape measures, and the time it stayed in the air (in seconds) using the stop watch. Each group will have *three tests with their plane*. Each group member will take turns when performing the role of timekeeper, tape measurer, data recorder or plane launcher.

(d) Run Group model activity

- In the second part of the group activity, students will d*evelop a group model* (detailed set of procedures) that will enable them to determine the winning plane from the data collected.

Testing

- Testing should be carried out in a wind-free environment, preferably in an enclosed, suitable sized location such as the school hall

- In the testing environment, place masking tape down to indicate the desired straight - line flight path, and use tape measure for ease of record taking (Place one masking tape line per group to facilitate the Group Activity testing)
- Issue a safety warning to students. This is repeated in their Student Workbook on pg 10.
- Explain the testing process, that is, distance measured, time in the air and flying in a straight line (students to record down "scratch" under both time taken and distance travelled if their flight is not in a straight line)

- Point out to students the questions within their workbook that they will be required to complete after testing their plane. They are to record these in their testing record sheets they created.
  - Questions for the Individual Student Activity testing:
    - Was your plane able to fly straight?
    - How far did it travel?
  - Questions for the Group Activity testing:
    - How long did your plane stay in the air for each test?
    - Was your plane able to fly straight?
    - How far did it travel for each test?
    - What did you notice about the data you collected for three tests?
    - How was your plane launched?
    - What would you change about the way you launched your plane and why?
    - What would you change about your design and why?

- **Individual Student Activity Testing:**
  - Break class into groups of two.

        - Each individual student will launch their plane once, while their partner records the "distance travelled", and vice versa
        - Each individual student records the result of their single flight, i.e. distance travelled in metres and centimetres if their plane flew in a straight line, or scratch otherwise
    - **Group Activity Testing:**
        - Each group has 3 tries and testing is done at their nominated spot where the masking tape has been laid out to indicate a straight line path for the particular group
        - Group members take turns to either launch, keep time (stopwatch), measure distance (tape measure) or record the flight details (time in the air or distance travelled)
        - Group members are encouraged to exchange roles for each flight attempt

ACTIVITY PROCEDURES

(A) BEFORE THE ACTUAL ACTIVITY, IF POSSIBLE (to save time)

The Engibear Dream Storybook

- Begin the activity by reading the storybook *Engibear's Dream* by Andrew King.
- Ask students to recount the main steps Engibear took to build his Bearbot – recording on the whiteboard as follows:
    - Identified a problem (He was busy and needed to share his work so he had time to dream)
    - Thought about his idea/solution (Bearbot)
    - Designed his Bearbot
    - Drew his plan

- Built his Bearbot
- Tested his design
- Redesigned/redrew/retested until he was successful.

(B) Preliminary Experiences (10 minutes)

- Advise students that today we are going to use our knowledge of the Engineering Model to solve a problem for QANTAS.
- Ask students if they have heard of QANTAS? If so, ask students to elaborate on the nature of the business.
- Ask students if they can suggest what types of engineers might work for QANTAS. Here are a few examples:
  - aerospace engineers have the ideas and design the planes
  - mechanical engineers design the engines
  - materials engineers look at what the plane is made of
- Advise students that today we are going to play the role of aerospace engineers, that is, those engineers who design and make planes.
- Discuss the term "aerospace". Ask students if they have heard of the word "aerospace" before and if they know what it means. (Teacher note: The word comes from the Greek word *aerios* concerning air, and space is related to the Earth's atmosphere and beyond. Aerospace engineering is the branch of engineering that is concerned with the design, construction and science of aircraft and spacecraft.)
  - Have students identify the main parts of a plane using a still frame of a plane from the video (Boeing *787 Flight Video Take-off and Landing HD.mp4* video clip):
    - Body
    - Wings
    - Tail

- Nose
- Wheels

(C) Main Activity

- Remind students that today we have been asked to solve a problem for QANTAS. QANTAS have heard that Grade 4 students in the Brisbane area are learning about engineering and thought we could help them with their problem. QANTAS have a Museum in Longreach, Queensland and part of the museum is an Education Centre.
- Up until now, the Education Centre has had mostly information for adults. They need some help developing educational material that primary school students can understand.
- Our task/challenge is to make a paper plane and write a fact sheet for other students about how to make a paper plane and how it flies.
- Explain the constraints and rules to students.
  - Your plane will be made from a single piece of A4 paper.
  - Your plane will be launched by hand.
  - Your aim is to make a plane that flies in a straight line, stays in the air for a long time and goes a long distance. We will be comparing the times and distances of the groups in the class.
  - As individuals you will make your own plane, label it with your name, and pair up with a classmate to test each other's plane performance, namely distance travelled. Each individual will get only one attempt at throwing their plane, and recording their plane's "distance travelled" into their workbook.
  - As a group, you will make a group plane and then test your plane. You will record the distance your group plane flew and the time it took. You will have *3 tests* of your group plane. You

will record the time and distance for each test. You will note variations in the data you collected, that is, how the data varied for the three "time in the air" and the three "distance travelled" measurements.

- As a group, you reflect on the results you obtained and will then redesign your group plane and try again to see if you can keep the plane flying straight, increase the time it stays in the air and the distance it travels.
- For each plane your group builds and tests, you are to measure the main features of the plane (overall length, width, wingspan, etc) and record these measurements on the drawings on pg 13 and 24 of your individual Student Workbook.

(D) TO WRAP UP THE ACTIVITY

- Play the Red Bull Paper Wings Competition clip (3:50 min)
- Provide students with the following information about the competition:
  - Red Bull Paper Wings World Finals are held every 3 years, next competition is sometime in 2018.
  - In the 2015 Red Bull Paper Wings World Finals competition held in Austria, 46,000 contenders from across the world competed with 535 qualifiers in 3 different categories:
    - Longest distance
    - Longest airtime
    - Aerobatics

    - Results:
      - ✓ Veselin Ivanov of Bulgaria was the winner of the longest distance with a flight of 53.22 metres.

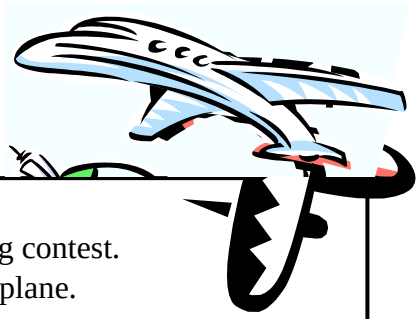
✓ Longest distance qualifiers from Australia were:

1. Lachlan Elliot 27.30 metres
2. Justin Halejko 25.20 metres
3. Nick Yang 23.20 metres

(E) DEVELOPING A GROUP MODEL FOR DETERMINING THE WINNER OF THE PAPER PLANE CLASS COMPETITION

- The final part of the activity is a modelling activity, which will be based on either the student's results (which would be better) or the data below. We would need to gather the data and place it in a table (like the one below) before the activity is implemented.
- Advise students about the group model criteria:
  - You are now going to determine a winner for the group planes you have designed and built.
  - Remember that your aim was to design a plane that would fly for as long as possible in the air (*time*) and over a long *distance* from a target. The plane had to travel in a *straight-line path*.
  - Three awards will be given at this contest. One will be given to the group whose plane stays in the air the longest – another to the group whose plane travels the longest straight-line path – and the final award is an overall award given to the group who wins the contest. You will need to decide how to determine this overall award. There are different possibilities or answers here. The important thing is that you explain how you determined each of the awards and explain why (justify) you think your approaches or methods are good ones for deciding on these awards.

The Annual Paper Airplane Contest



This year, your School will hold their annual paper airplane flying contest. Students in year 4 will be working in groups and will design one plane.

All planes will be designed to fly for as long as possible in the air (*time*) and over a long *distance* from a target. The plane will need to travel in a *straight-line path*.

Three awards will be given at this contest. One will be given to the group whose plane stays in the air the longest – another to the group whose plane travels the longest straight-line path – and the final award is an overall award given to the group who wins the contest.

Results from last year's Annual Paper Airplane Contest

Team	*Attempts*	*Time in the Air (seconds)*	*Distance travelled in a straight path (metres)*
Team A	1	2	11
	2	2	12
	3	scratch	scratch
Team B	1	3	12
	2	1	7
	3	1	8
Team C	1	1	9
	2	3	11
	3	2	11
Team D	1	3	12
	2	scratch	scratch
	3	1	8
Team E	1	2	9
	2	1	10
	3	2	13
Team F	1	1	9
	2	2	11
	3	scratch	scratch

Investigation

In the past years, the judges have had problems with deciding how to select a winner and how to judge the contest. Using the given data from the previous years, find a way to help the judges decide on the overall winner of the contest.

Write a letter to the judges of the contest explaining to them how to determine who wins each of the categories (time in the air and distance travelled in a straight-line path) and how to decide the winner of the overall award for the contest.