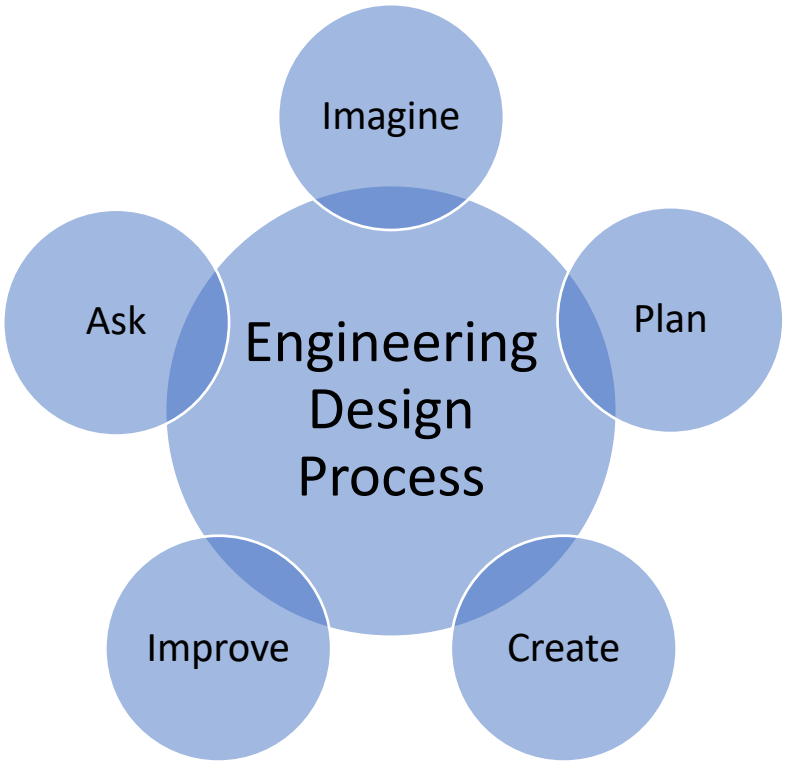
The Engineering Design Process
and
Paper Airplanes

In this activity you will put the engineering design process into action as you design, build and test a paper airplane. The engineers at iFLY use a very similar process to create new and improved wind tunnels. They are constantly working on ways to make our tunnels more realistic and more fun while keeping everyone safe! Keep in mind that this process is circular – it never ends. As soon as our engineers have a new design, they are already imaging ways to make it even better. Today, you will use the 5-step engineering design process shown below to build your airplane – ask, imagine, plan, create, and improve.



1) ASK:
   a) What is the problem?
      i) Easy – Design a paper airplane that flies a long distance (69.14m is the world record).
      ii) Medium – Design a paper airplane with an accurate flight path (this can be measured either by distance from center line or closest to a target).
      iii) Challenging – Design a paper airplane that stays aloft for a long time (29.2 seconds is the world record).

b) What are your constraints? Since you are completing this activity at home, the constraints will vary. Things to consider include:
   i) Time – We recommend at least 30 minutes to complete the activity but increasing the time will usually improve the end results.
   ii) Space – If you choose to do this activity indoors, then the test zone will have limited length and height depending on where you decide to set up inside your house. If you conduct the activity outside, the length and height of your test zone will be increased dramatically (possibly unlimited thus removing this as a constraint).
   iii) Environmental Factors – Air movement from the AC/Heat (inside), wind, rain, etc. (outside).
   iv) Resources – Gather supplies that you already have at your house that you can use to build a paper airplane. Some examples include:
      (1) Different types of paper (copy, construction, etc.)
      (2) Scissors
      (3) Tape
      (4) Rulers
      (5) Pencils
      (6) Paperclips
   v) Minimum flight requirements – These are optional but may include some of the following:
      (1) Airplane must travel at least ___ meters.
      (2) Airplane must stay aloft for at least ___ seconds.
      (3) Airplane must not land more than ___ meters from center line.

2) IMAGINE: What are some solutions? Before you can make a good design, let's review the forces affecting the paper airplane. These are the same four forces that affect real airplanes – weight, lift, drag, and thrust.
   a) Easy:
      i) Name the two forces pulling: _____ and _____.
      ii) Name the two forces pushing: _____ and _____.
   b) Medium – Identify what the airplane will be doing if:
      i) Weight is greater than lift = _____
      ii) Lift is greater than weight = _____

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iii) Drag is greater than thrust = _____

iv) Thrust is greater than drag = _____

v) All forces are balanced = _____

c) Challenging – List at least two ways to change each of the forces acting on your paper airplane:

i) Weight:

(1) _____

(2) _____

ii) Lift:

(1) _____

(2) _____

iii) Drag:

(1) _____

(2) _____

iv) Thrust:

(1) _____

(2) _____

3) PLAN – Now you are ready to brainstorm ideas for your airplane design. Draw a diagram or sketch of what your airplane will look like. Keep in mind your constraints – especially your materials.

4) CREATE – Build your plane and then test it out.

a) Your test zone should have marked a start line and a center line.

i) Use either masking tape or string.

ii) If desired, create a target for the medium level activity.

iii) Have tape measures and stopwatch available in the test area.

b) Launch your airplane from the start line and then measure:

i) Easy – Total distance the plane travels (in meters).

ii) Medium – distance from center line or target (in centimeters, hopefully).

iii) Challenging – time from release until plane lands (in seconds).

c) Record your data.

d) Repeat steps b and c at least two more times.

5) IMPROVE – Use the time you have left to modify your design and retest.

a) What worked well with your design? What didn't?

b) How can you improve the airplane's performance?