Week 19: Flight and Paper Airplanes

But those who trust in the LORD will find new strength. They will soar high on wings like eagles. They will run and not grow weary. They will walk and not faint. Isaiah 40:31

Background:

1. History shows that people have had a fascination with flight for a long time.
    a. Has anyone ever heard of the Greek Myth of Daedalus and Icarus?
        i. Daedalus made wings for his son Icarus and himself from sticks, feathers, and wax to escape a labyrinth.
        ii. Icarus ignored his father's repeated warnings and flew too close to the sun, and the wax on his wings melted.
        iii. And he fell into the sea and drowned.
        iv. The story is about flying, but the moral is the importance of obeying your parents.

    b. Who has ever heard of Leonardo da Vinci?
        i. He was one of the most brilliant inventors and artists of the Renaissance.
        ii. He was fascinated with flight, and designed and invented numerous machines that, in the end, did not end up flying.

    c. Does anyone know who made or where the first successful airplane flight occurred?
        i. The first successful powered flight was achieved by the Wright Brothers in 1903 in Kitty Hawk, North Carolina.
        ii. It was only just over a 100 years ago!

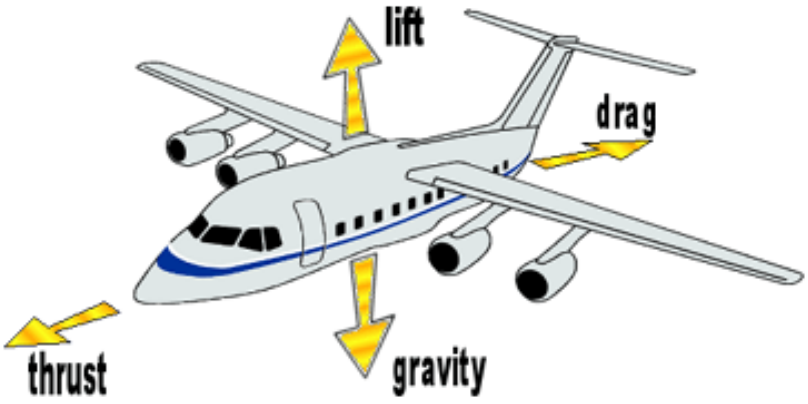
2. Who has ever seen an airplane flying before? And who has ridden on an airplane before?

Introduction:

1. Over the last few weeks we have learned a great deal about motion and forces.
    a. Does anyone remember some forces have we learned about already? Friction, air resistance, gravity
    b. And motion is governed by Newton's Laws which are:
        i. **Newton's First Law** states that an object at rest tends to remain at rest, and an object in motion tends to continue moving in a straight line at constant speed unless an outside force acts upon it.
        ii. **Newton's Second Law** States that Force equals mass times acceleration. F=ma
        iii. **Newton's Third Law** states that for every action there is an equal and opposite reaction.

2. There are 4 forces of flight used to describe airplane motion.

Four forces of flight



Lift - upward
Drag - backward
Weight - downward
Thrust - forward

3. **Drag** is the **force** generated by the **resistance** of the air as the plane moves through it. So if we want to build a plane that will fly well, we need to minimize the **drag force** on our paper airplane.

4. **Gravity** is force that pulls the paper airplane towards the ground. What can we do to minimize this force? Make the plane light!
    a. (***Optional connection for older classes***)
    b. Newton's 2nd Law:
    c. Gravitational **Force = Mass x Acceleration**
    d. Less mass in our airplane means less gravitational force
    e. (***End Optional connection***)

5. **Thrust** for real airplanes comes from engines or propellers, but paper airplanes are actually **gliders**, which are aircraft without engines.
    a. For our glider paper airplanes, we have an initial input of **kinetic energy** that contributes to thrust and quickly dissipates.
    b. Where does the kinetic energy (energy of motion) for the paper airplane come from? Your arm!

6. In order to fly, airplanes must overcome gravity and their weight, and this last force is called **lift.**

7. Has anyone ever made a paper airplane before?
    a. Did it fly well? If it did, do you have any tips for building one?
    b. If it didn't, do you have any idea why?

8. If we were going to build the perfect paper airplane, what are some things we might consider or think about? (The older kids will likely have ideas, but the prompts below will help the younger ones along)
    a. Do we want it to go far?
    b. Should it be easy to build?
    c. Should it look neat or cool?
    d. Do we want it to be stable and not break easily?

9. What features do you think we might need for our perfect paper airplane? (The older kids will likely have ideas, but the prompts below will help the younger ones along)
    a. Should the wings be big or small?
    b. Should we make the plane heavy or light? (You may or may not mention this would have to do with the thickness of the paper we choose.)
    c. Should it be **symmetrical**? Meaning, should it be the same on both sides? Can the wings be of different lengths for it to fly well? Have you ever seen a plane have different wings? (One can only hope no child says yes ☺)

Materials:

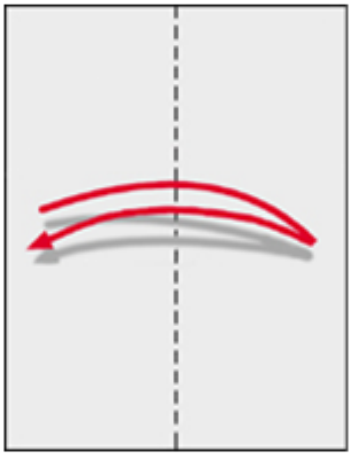
1. Copier/printer paper
2. Possibly a tape measure (if you want to take measurements)

   A few options mentioned in **Variations** would require different types of paper, rulers, scissors, or art supplies.

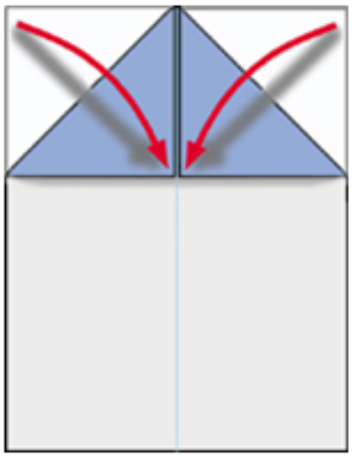
****In an attempt to keep order when making and flying the planes, I came upon this suggestion: Inform the kids that everyone starts out with a **"Pilot's License,"** but if they choose to fly their plane before you have given permission, it will be revoked, and you will kindly fly their planes for them. ****

Procedure for folding a Dart Paper Airplane:

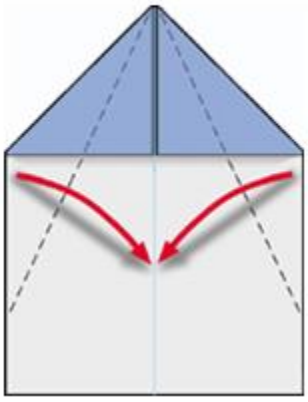
Step 1.
Use a sheet of 8 1/2-by-11 inch paper. Fold the paper in half lengthwise and run thumbnail along the fold to crease it sharply. Now, unfold the paper.



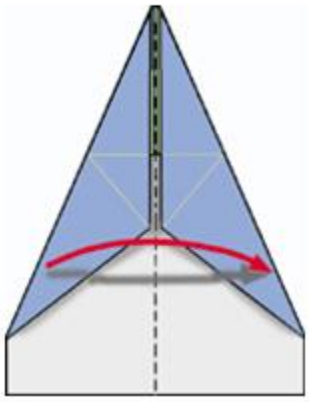
Step 2.
Fold down the top corners as indicated by the arrows.



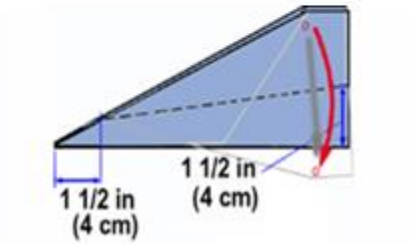
Step 3.
Fold the two edges toward the center line, as indicated.



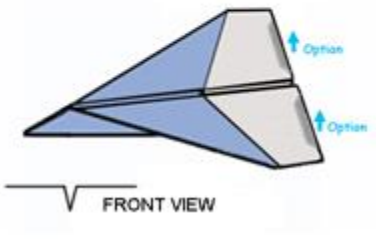
Step 4.
Make a valley fold in half. Turn the plane 90 degrees as shown in figure of Step 5.



Step 5.
Create a wing crease that begins at the nose as shown.



Step 6.
Form 3-dimensional shape as shown in figure. The Basic Dart is complete.
Bend up the tailing edge of the wings for lift if it has a tendency to nose-dive.



Variations

1. After the kids build the planes, you might have them fly them and compare the distances each one flies.
2. **For the older kids**, you might invite them to make a modification to his or her plane that they think will help it fly better (this will work best if your entire class made the same plane).
3. **For the older kids,** use the designs in **Appendix 1** and then have them each build a different plane. Then have them hypothesize as to which ones they think will fly best and why.
4. **For younger groups**, you might consider making their planes in advance and having them color or decorate them as an activity while you discuss airplanes. This will be largely dependent on how much parental help you have in your class.
5. As mentioned in the discussion, you can have the kids try making the same plane from construction paper or card stock versus copy paper or have them make a plane from a full sheet of paper and then one from a smaller sheet (with the same relative dimensions, so 8.5x11 in sheet at half size would be 4.25x5.5 in).

Discussion: (***skip for youngest classes***)

1. What would happen if we changed the thickness of the paper which would change the weight of the paper? Then the gravity force would increase because It would be heavier.
    a. Something fun to try at home is keeping the same design but using copy paper, construction paper, or newspaper, and seeing which plane flies the farthest.
    b. You will likely need to fly each plane several times to be able to get a good comparison.

2. What do you think would happen if we had bigger pieces of paper to make our planes? Or if we made them smaller?
    a. **This is a thought question** because so much depends on the conditions, thickness of the paper, design, where you are flying it…..
    b. The **wind** that you can get to give you **lift** is likely one of the biggest factors.
    c. The world record for biggest paper airplane has a wingspan of nearly 60 feet! That's HUGE!

3. Or what if we did this outside, and it was windy? **Another thought question to get them thinking**. Then depending on the direction our airplane was flying it could have more thrust or drag. So it could fly further or not nearly as far depending on the direction of the wind, and the direction we were throwing it.

4. What if we changed the nose (front tip) of the plane? Would it glide through the air differently? Yes, it would. And it would be a great experiment for you to try out at home!

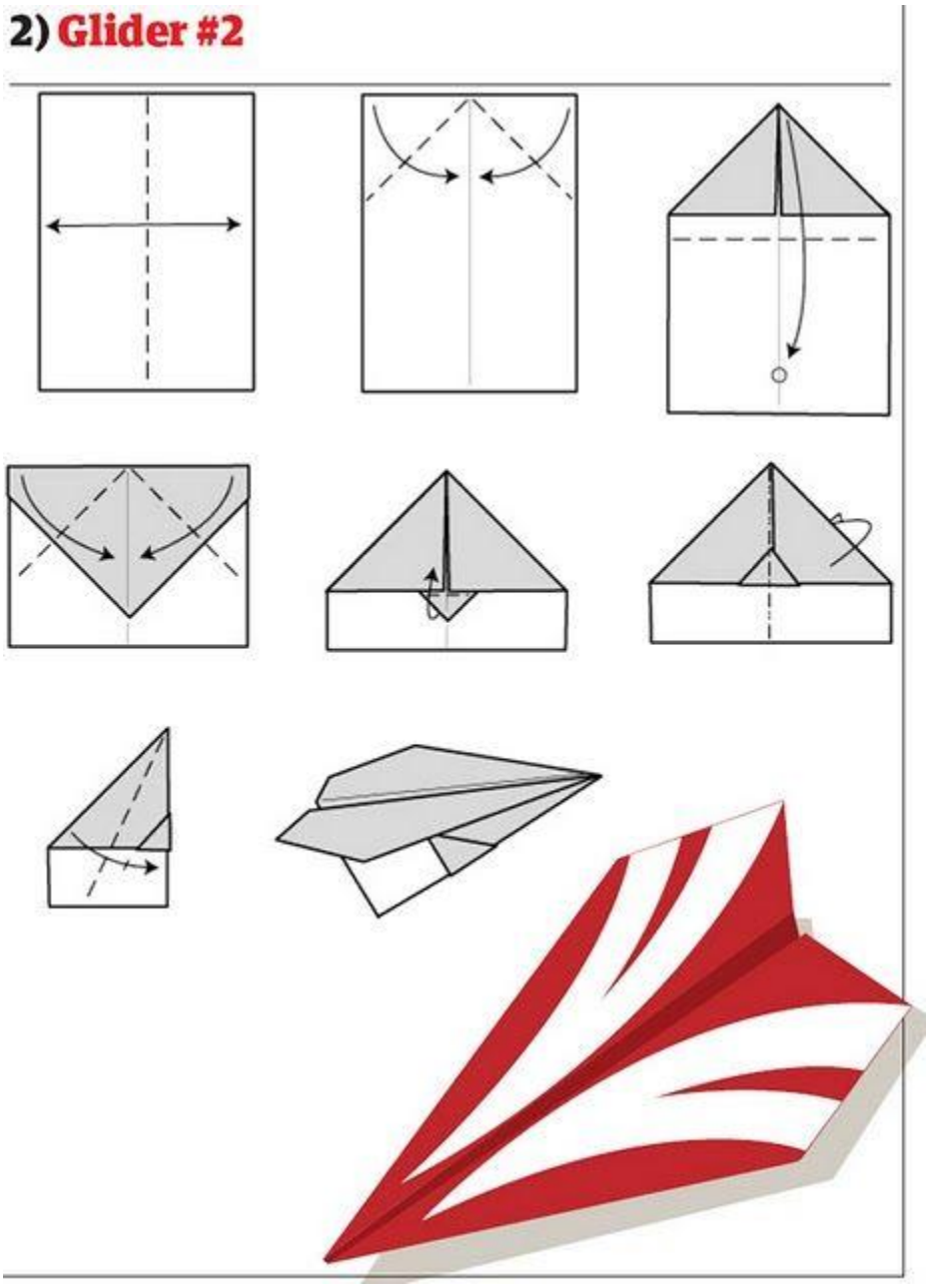
5. When we studied astronomy, I mentioned that there were a number of great careers in the aerospace industry.
    a. The aerospace industry studies, designs, builds, and tests all kinds of vehicles such as airplanes, helicopters, balloons, rockets, missiles, satellites, and spacecraft.
    b. If you think this subject is interesting, there are many career options in this field.

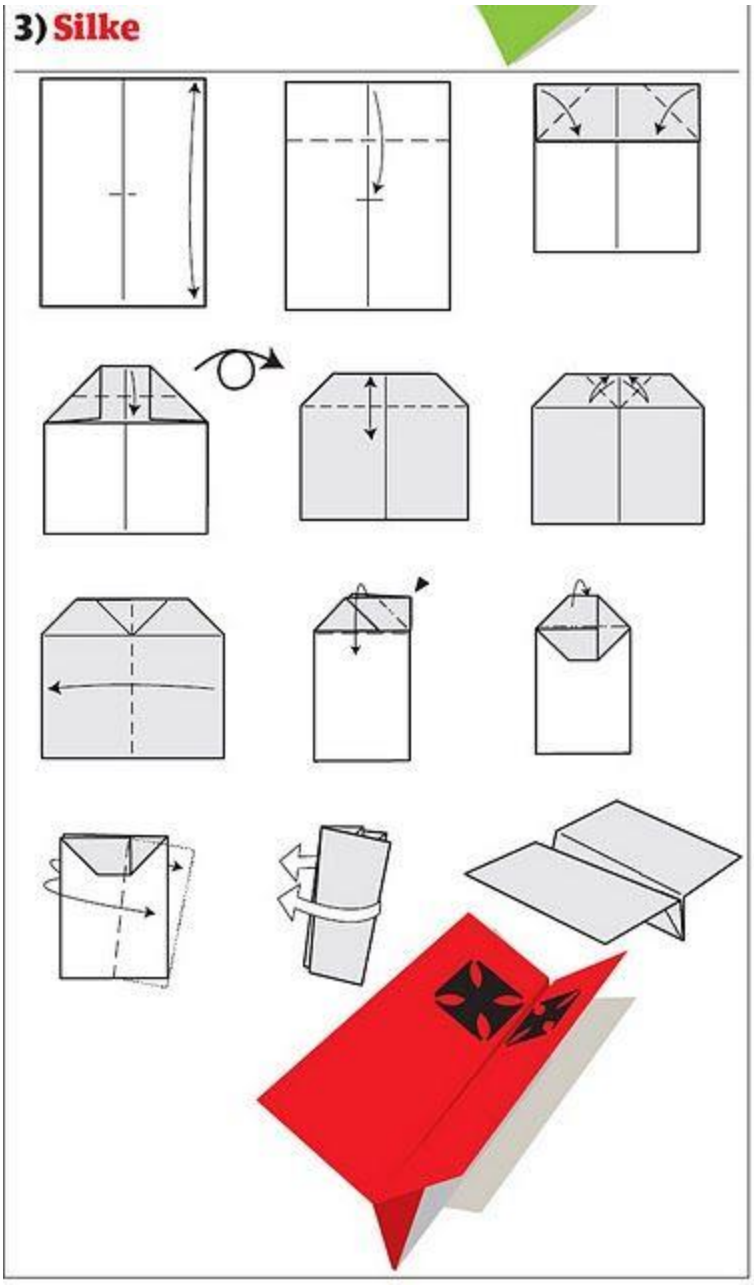
***Teaching note for all of my scientist and engineer friends- I wanted to include a section on how airplanes generate lift and stay in the air. However, to my amazement, the physics behind this is not settled, and according to NASA, reported incorrectly almost everywhere. Therefore, it is omitted, but if it comes up, you can relate the motion to something called Bernoulli's Principle which dictates the flow of liquids and gases (like air over an airplane wing) at high velocity). If you are further interested in the topic please take a look at https://secretofflight.wordpress.com/incorrect-theories/ ***

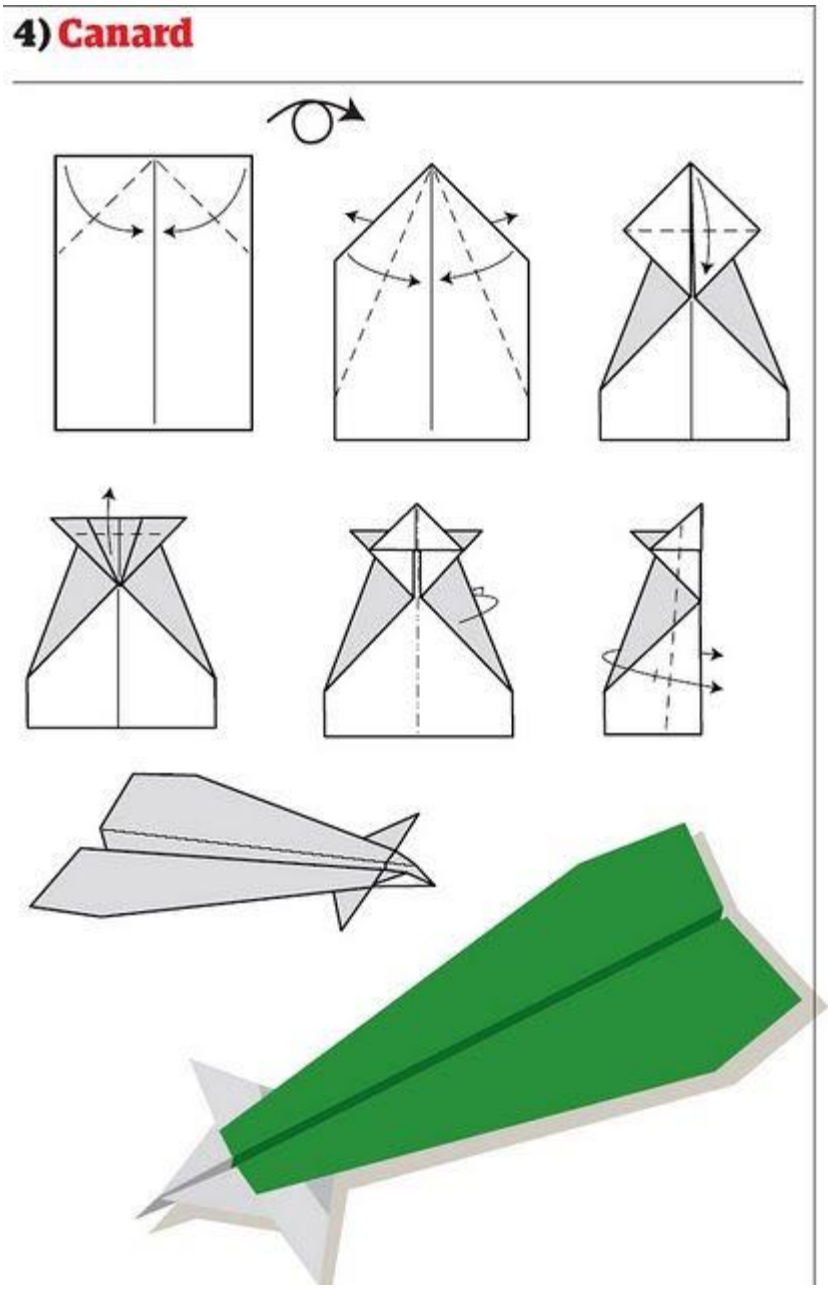
Appendix 1: Other Airplane Designs

From: http://www.damncoolpictures.com/2011/03/how-to-build-cool-paper-planes.html

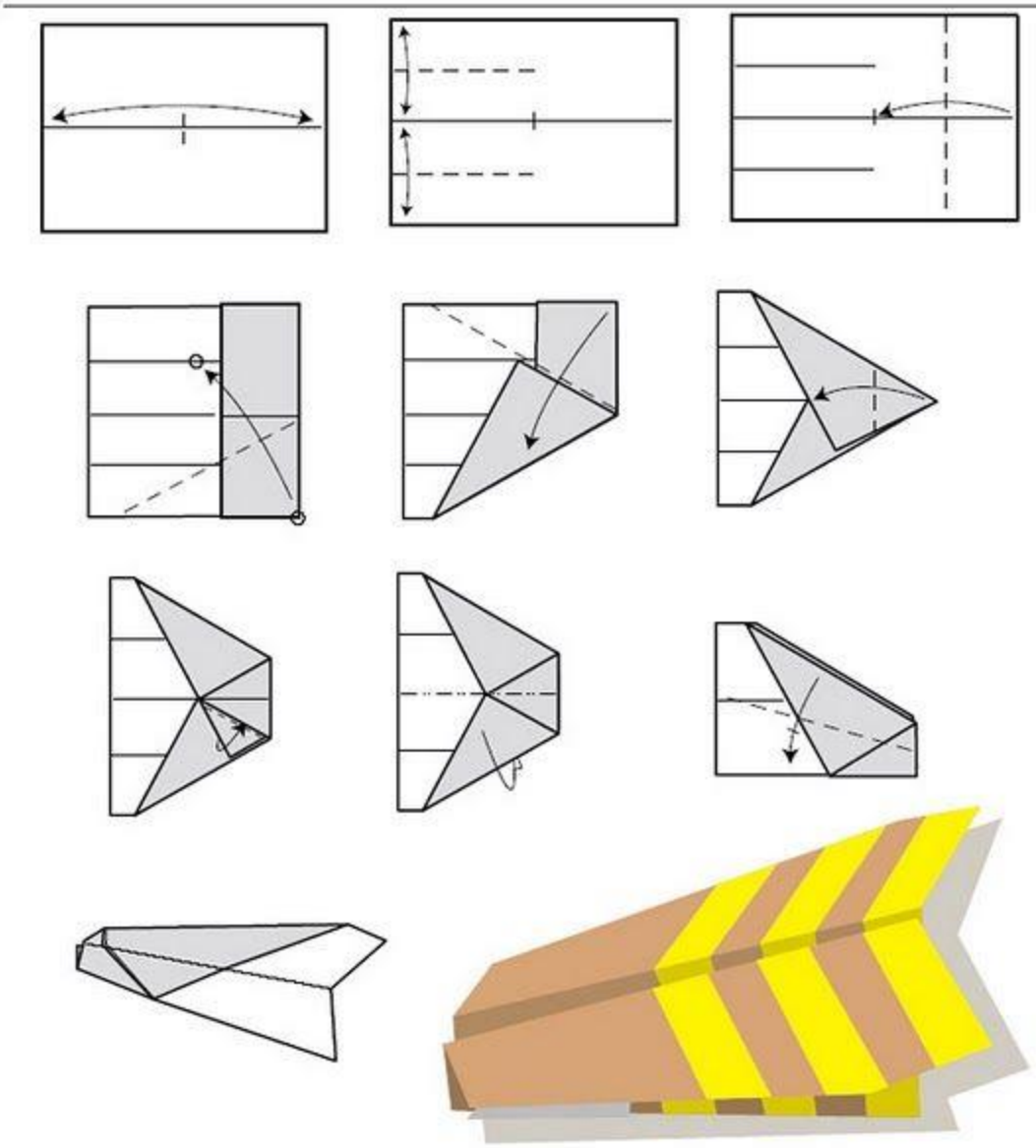
****In the event your young aviators are well-beyond the dart, I am including some other designs. If you have some aviators you think will be bored all making the same plane, you can bring in a different design for each one of them as a challenge and then compare how they fly.****

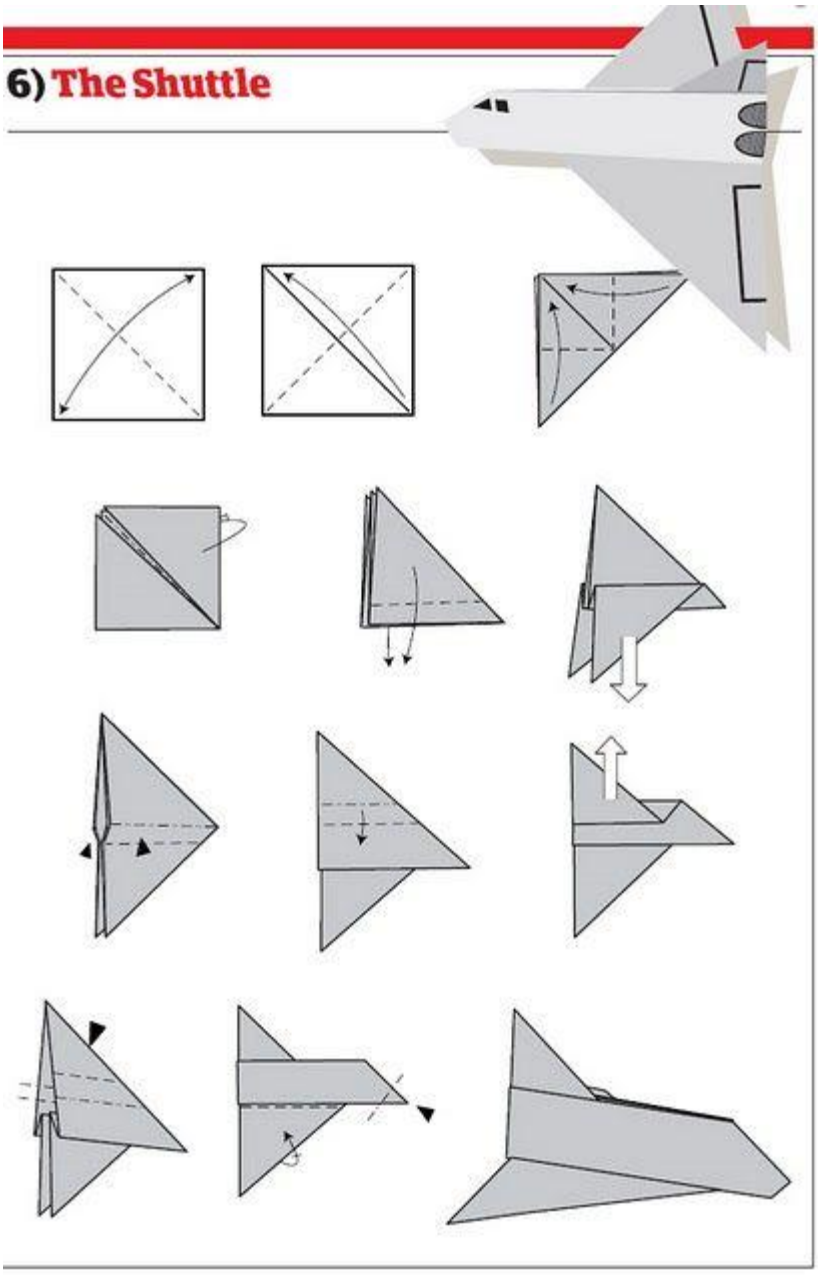


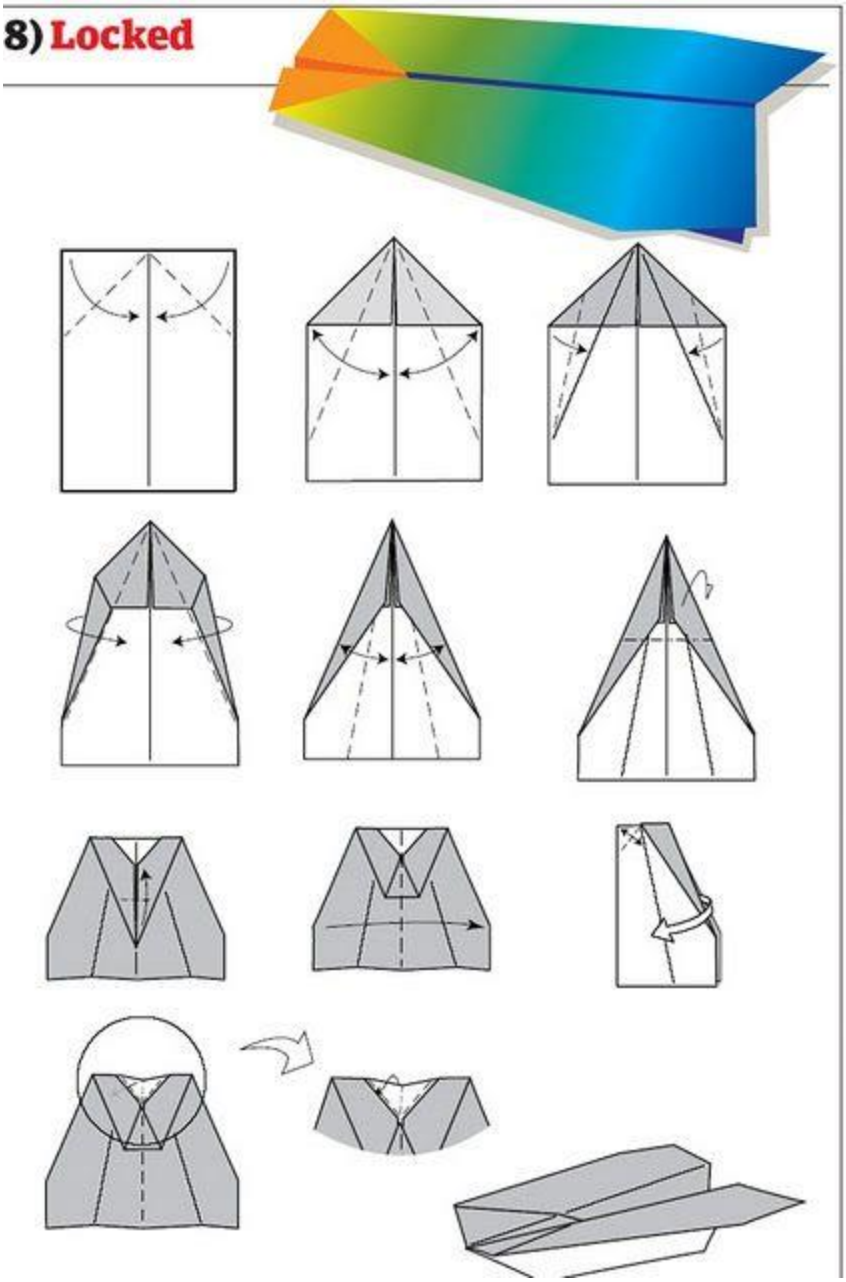

3) Silke


4) Canard

5) The Delta




6) The Shuttle


8) Locked

12) Little Nicky