A workshop made by FabLab+
Reworked by Senne Henderickx and Tim De Clercq

Paper Planes

Focus on Group work

Stimulate problem solving	**Gold**	**Stimulate entrepreneurship**	**Gold**
Stimulate creativity	**Gold**	**Informal learning enviro.**	**Silver**
Stimulate critical thinking	**Silver**	**Technology use**	**Bronze**
Stimulate group work	**Platinum**		

Practicalities

Preparation: 0.5 h

Duration: 1 h 40’ (or 2 lessons of 50’)

Material needs:

- a big stack of used sheets of preferably A4 papers: copy-paper/magazines/ papers/carton/books (make use of what is already laying around)
- Maybe collect the used paper from all the waste paper around a school/area!
- eight scissors, some pencils four glue guns/glue sticks and a bunch of paper clips
- other materials: There is no specific limitation to what can be used in the classroom. This is determined by the instructor of this project.

Group size range: 12-30
Ideal sub-group size: 4-6

Workshop made for: 12-16
Easily transferable to workshops for ages between: -12/+16

Environment FabLab necessary: no
other environment necessary: a big open space close by for testing like a study room

Educational area:
* Engineering

Precognition

The participants don’t need to know anything about actual planes or paper. The essence of this activity is not about acquiring new knowledge or researching how planes work through the use of paper. This workshop is mainly about learning to work together in a cohesive manner and about entrepreneurship.

Preparation

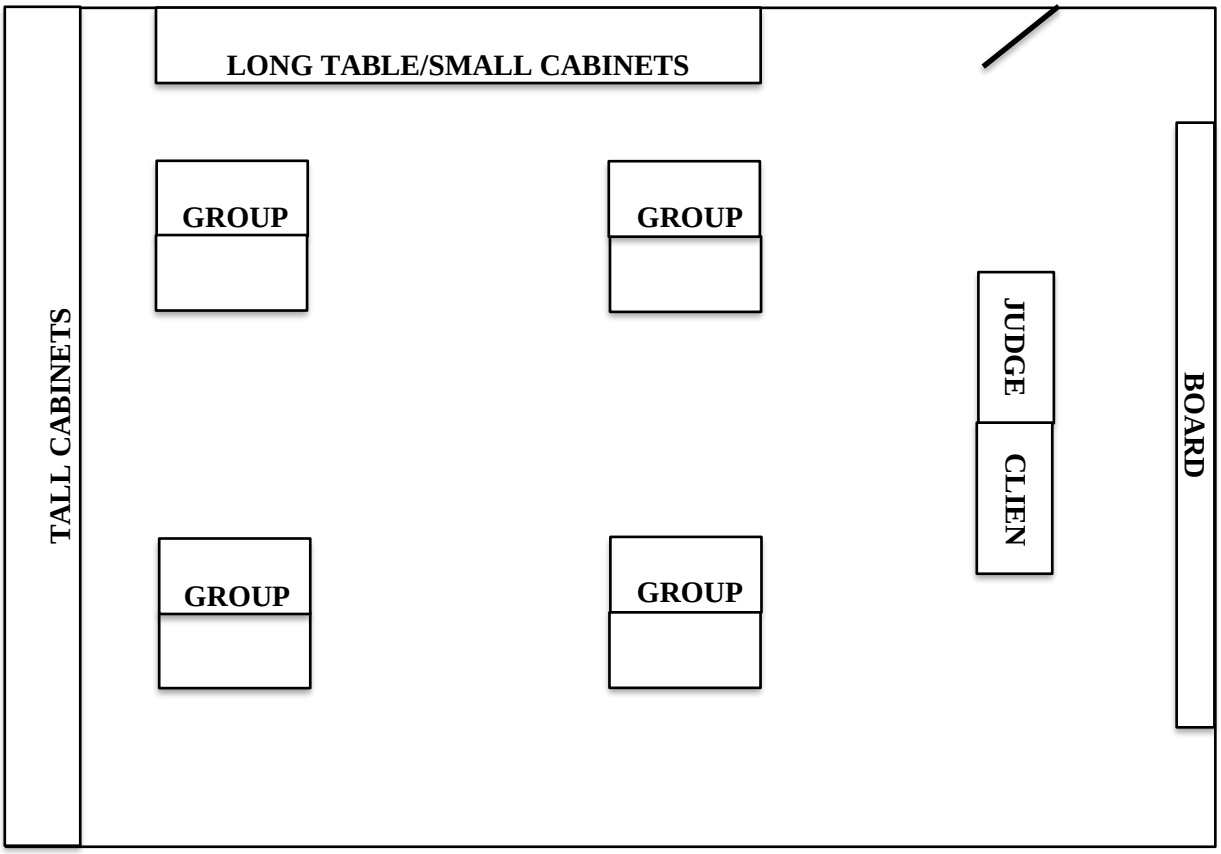
Prepare the organization and explanation in advance. Use tools like a presentation, a whiteboard or a folder to visualize the structure of the workshop. Gather the necessary materials and start planning.

Put the materials for every group in a box. Create groups of four to six students, depending on the size of the class and the space that is available. Every group will get a workstation and a testing ground. The testing ground can potentially be shared by all the groups if there is limited space available.

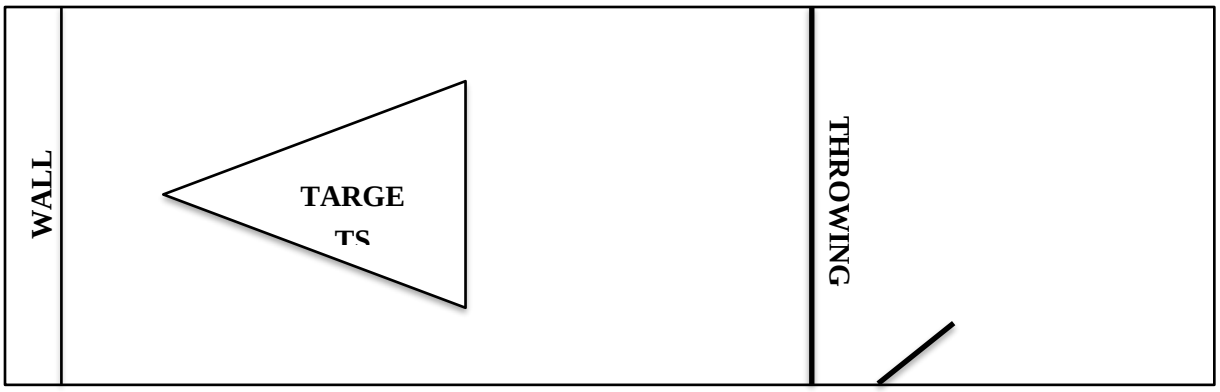
Make sure that the workstations are far enough from one another for no disturbances. These stations are ideally in the form of a square with enough room for every group member. This way every group can communicate and work together more smoothly. Put the names of the group members on their table.

The testing ground is either a long open space or a hard wall. This location doesn't have to be in the same space/room as the workstation. For example an adjacent open hallway, an open grass field, a gym room. Do keep the distance between locations as short as possible.

Make sure there is also some room left for a board of jury. They judge the work from every group so ideally have a good view what every group does during production.



EXAMPLE OF A STANDARD



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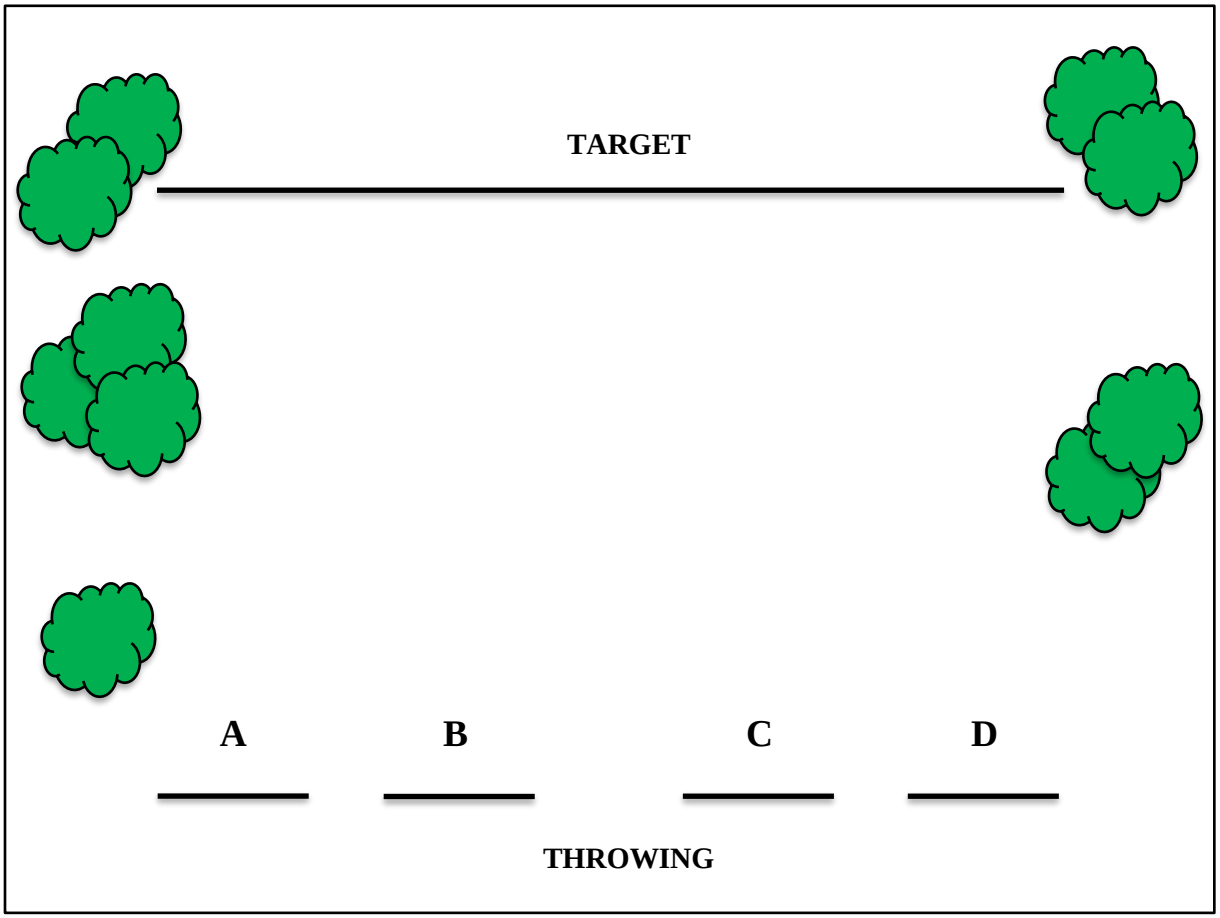

EXAMPLE OF AN OPEN AREA

Workshop Guidelines

First production cycle: creativity

Phase 1: Orientation and instruction phase

Material needs:
Essential: 100 pages of paper
Optional: 10 pages of cardboard, 2 pair of scissors, 2 glue sticks

Goals:

Skill Goals (**Blue**)
(S1) working together
(S2) leadership: natural leadership (without voting of without discussion who takes the lead) or democratic leadership (who takes up what role)
(S3) communication: listening, repeating the heard, explaining, asking questions at appropriate times, agreeing on certain aspects
(S4) problem solving
(S5) social skills: reading the group, reading the others, becoming part of a whole, adding personal value to the team
(S6) Self-regulation
(S7) Critical thinking
(S8) Creative thinking

Content Goals (**Green**)
(C1) *Spatial insight*
(C2) Aerodynamics
(C3) Research based learning

Background story:

This workshop is based on the 21st century skills and a first step in getting to know project management and scrum sprints. This means there are specific rules that need to be followed to win the game. Breaking rules will result in deduction of points or elimination of planes which will make it very difficult to win the game.

The groups are all a team. They will be able to choose a name, the teams will have a team leader, initial event the client will speak to all the teams and explain the first set of rules. All the next meetings only the team leader will speak directly to the client. Every team gets 1 token – this token can be used to ask additional help only once (time out). If a team did not use the token, they will get 10 extra credits at the end of the game.

Goals	Activities	Duration
S1-S8 C1-S3	**INTRODUCTION** To start the first production cycle, make use of the short backstory as an introduction. The introduction is very important. This determines the motivation of the participants. Give this the necessary panache. Show some paper planes to excite everybody or show a video about world records being broken by these planes. Give all the teams a visual engaging challenge that will be awaiting them. Firstly, form the teams. Let every member choose a group role. For an extensive view of the group roles, see the second attachment. Let the group choose a name. These will be noted on a big score board. Secondly there are specific rules that every team needs to follow. These rules will now be explained. Pay good attention because they won't be repeated again. During this explanation you can ask a question about the rules but afterwards you won't be able to ask without a deduction of points. A single copy of these rules will be given to the rule keeper of every group. Don't forget that. Listen very carefully to the following rules: 1) There are multiple stages during a production cycle. The first stage is a development stage. In the development stage you can test and modify every plane you have folded with your team. The second stage is the judging stage where the work of your team gets used and evaluated. 2) Every person can only fold once in succession. The model then needs to be passed to an adjacent member to perform an next action/fold and so on. An action consists either out of one fold, one cut, one connection with glue et cetera. Every time a group cheats, their model will be discarded. 3) Each team will be assigned a testing ground. One group member (no specific role) can test a plane while the others design another. 4) Each team has a certain amount of time to test and develop one or more prototypes. 5) TIP: Do not discard prototypes! They may come in handy later. 6) Each team has a similar amount of materials. Use them creative. 7) When the timer rings the presenter of every group will bring the prototypes to the client for try-outs and evaluations. 8) Breaking the rules will result in a deduction of points or elimination of prototype planes. Thirdly, this project works with a scoreboard. Points can be earned by gaining points from the judge, completing additional special challenges and by not using a token. At the end of a production cycle, the judge will evaluate your design and give it points. Every group gets a token for every production cycle. The group can choose to use these tokens for an extra tip. If they don't use it they will receive an additional two points on their score. Cycles can also be given for beating the special design challenge of that production cycle. For example the plane that flies the furthest, the plane with the longest wing span to bridge a distance of 10 meters.	15'

Phase 2: Design phase

Material needs:
Essential: same as above

Goals:
Skill Goals (**Blue**)
(S1) working together
(S2) leadership: natural leadership (without voting of without discussion who takes the lead) or democratic leadership (who takes up what role)
(S3) communication: listening, repeating the heard, explaining, asking questions at appropriate times, agreeing on certain aspects
(S4) problem solving
(S5) social skills: reading the group, reading the others, becoming part of a whole, adding personal value to the team
(S6) Self-regulation
(S7) Critical thinking
(S8) Creative thinking

Content Goals (**Green**)
(C1) *Spatial insight*
(C2) Aerodynamics
(C3) Research based learning

Goals	Activities	Duration
S1,2,3,4,5,6,7,8 C1,2,3	**DESIGN SPECIFICATIONS FOR THE FIRST PRODUCTION CYCLE** The client gives the design specifications. ▪ Build the paper plane that can knock over the highest amount of objects (make an easy obstacle course) at a distance of at least 3 meters. ▪ special challenge “FLYING FORTRESS”: Build the paper plane with the highest total mass that can fly for a distance of at least 3 meters. ▪ special challenge “ROLLING THUNDER”: Build the paper plane that knocks the furthest obstacle away. Only three planes can be submitted.	2’

Phase 3: Making Phase

Material needs:
Essential: same as above

Goals:
Skill Goals (**Blue**)
(S1) working together
(S2) leadership: natural leadership (without voting of without discussion who takes the lead) or democratic leadership (who takes up what role)
(S3) communication: listening, repeating the heard, explaining, asking questions at appropriate times, agreeing on certain aspects
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(S8) Creative thinking

Content Goals (**Green**)
(C1) *Spatial insight*
(C2) Aerodynamics
(C3) Research based learning

Goals	Activities	Duration
S1,2,3,4,5,6,7,8 C1,2,3	**DEVELOPMENT STAGE** Teams works together in creating prototypes, following the limitative rules and keeping an eye on their own time. When the time is over, the presenter brings the prototypes (all of them) to the client for evaluation. The presenter can tell a bit about certain prototypes if they want to.	13’

Phase 4 & 5: Operational and evaluation Phase

Material needs:
Essential: same as above

Goals:
Skill Goals (**Blue**)
(S1) working together
(S2) leadership: natural leadership (without voting of without discussion who takes the lead) or democratic leadership (who takes up what role)
(S3) communication: listening, repeating the heard, explaining, asking questions at appropriate times, agreeing on certain aspects
(S4) problem solving
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(S6) Self-regulation
(S7) Critical thinking
(S8) Creative thinking

Content Goals (**Green**)
(C1) *Spatial insight*
(C2) Aerodynamics
(C3) Research based learning

Goals	Activities	Duration
	JUDGE STAGE The client briefly tests and evaluates the designs of all the teams. The cycles for the special challenges are rewarded and the judge gives a score to every group. If possible take enough time to appreciate the work of the participants and give concrete feedback to the groups.	5’

second production cycle: quantity

phase 1: requirement phase

material needs:
a big bulk of different kinds of waste paper
optional: scissors, glue sticks/glue guns, pencils, paper clips et cetera

phase 2: design phase

	DESIGN SPECIFICATIONS FOR THE SECOND PRODUCTION CYCLE The client gives the design specifications. ▪ Build the highest amount of paper planes that can span a distance of at least five meters. ▪ special challenge “BARE BONES”: Build the paper plane with the least amount of folds or actions necessary to build it. ▪ special challenge “BLACKBIRD”: Build the paper plane that can fly the furthest over a height of 3 meters. More than one plane can be submitted.	2 min

phase 3: creation phase

S 1-8 C 1-3	**DEVELOPMENT STAGE** Teams works together in creating prototypes, following the limitative rules and keeping an eye on their own time. When the time is over, the presenter brings the prototypes (all of them) to the client for evaluation. The presenter can tell a bit about certain prototypes if they want to.	18 min.

phase 4-5: operational and evaluation phase

	JUDGE STAGE The client briefly tests and evaluates the designs of all the teams. The cycles for the special challenges are rewarded and the judge gives a score to every group. If possible take enough time to appreciate the work of the participants and give concrete feedback to the groups.	5 min.

third production cycle: quality

phase 1: requirement phase

material needs:
a big bulk of different kinds of waste paper
optional: scissors, glue sticks/glue guns, pencils, paper clips et cetera

phase 2: design phase

	DESIGN SPECIFICATIONS FOR THE THIRD PRODUCTION CYCLE The client gives the design specifications. ▪ Build the paper plane that can span the longest distance. ▪ special challenge “SCRAPPER”: Build the paper plane with the narrowest wing size that can span a distance of at least10 meters. ▪ special challenge “DRAGON”: Build the paper plane with the widest wing size that can span a distance of at least 10 meters. ▪ special challenge “EYECATCHER”: Build the paper plane with the best symmetrical folding lines. More than one plane can be submitted.	2 min

phase 3: creation phase

S 1-8 C 1-3	**DEVELOPMENT STAGE** Teams works together in creating prototypes, following the limitative rules and keeping an eye on their own time. When the time is over, the presenter brings the prototypes (all of them) to the client for evaluation. The presenter can tell a bit about certain prototypes if they want to.	18 min.

phase 4-5: operational and evaluation phase

	JUDGE STAGE The client briefly tests and evaluates the designs of all the teams. The cycles for the special challenges are rewarded and the judge gives a score to every group. After the third and last production cycle a winning team will be selected. But before the client reveals the winner, the client can discuss with the teams what they value to be the best paper plane of this workshop and why. This is a perfect moment to evaluate this project and to assess what the students learned from this workshop about paper planes. Take enough time to exchange experiences.	15 min.

PEDAGOGICAL TIPS

VARIATION IN DIFFICULTY:

Change the specifications of the client. Make them more challenging by adding more or harder to achieve specifics. The time for each challenge can also be changed to create more or less pressure.

- The prototype needs to cross a longer distance.
- The prototype needs to be constructed out of at least three different kind of paper types.
- The prototype needs to have a wing span of at least 10 cm.
- Create more special challenges. Be creative. For example, special challenge “Frankenstein”: Build the paper plane with parts of different other paper planes. This challenge could come after the second production badge.

VARIATION IN CLASSES:

This project is suited for other classes. A little change of the specifications and this project can be used for classes like art, math, IT, science, physics et cetera.

- Create a paper plane and design it with your custom paint job using all kinds of art utensils. Afterwards all the designs can be auctioned by the class. This way everybody gets to make his own creation and gets to rate the other creations in the class.
- Use paper planes to learn about angles, charts and curves. Create a test area and use the paper planes from the students. With the results from those tests, all kinds of graphs can be made.
- Let students create a paper plane on the computer using design software.
- Use paper planes to study the laws of aerodynamics, forces.

HOW TO TRANSFER TO A NON-FABLAB ENVIRONMENT

There are a few things essential to make the project work. The first and most important aspect is an open space close by as the testing area. This project revolves around paper planes. Nothing is more sad than making something for two hours and not being able to see it perform. The testing ground can potentially be shared by all the groups if there is limited space available.

The second aspect is a normal classroom with enough desks to organize the groups. The desks are necessary to create workstations . Ideally the workstations are far away from one another and in the form of a square. Make sure there is also some room left for a judge/client. They judge the work from every group so they best have a good view of what every group does during their development.

EVALUATION OF ACHIEVEMENTS

Every judge stage is an evaluation, but the final judge stage is the moment to gather the entire group and ask what they learned from each other during the testing of the planes. Questions like: How did they experience this groupwork? What did it feel like? What frustrated them? What gave them a feeling of success? What did they learn from the other team without working with them?

CONTENT LINKS

For a tip sheet see the fourth attachment. At the back there is a list of the used sources. There are also links to some videos and channels on YouTube dedicated to folding paper planes for those that can’t get enough.

attachment 1: group roles

MATERIAL MASTER

WHAT DO I DO?

- I get the materials and divide them.
- I bring back the materials.
- I make sure everybody helps to clean up.
- I make sure we take care of the materials.

WHAT DO I SAY?

- Do we have what we need?
- I will get the materials.
- Everybody needs to help to clean up.
- Help along!
- Who has got the … ?
- We gotta take care of our materials.

PRESENTER

WHAT DO I DO?

- I present our designs to the judge and the classroom.
- I ask my group on what to highlight.
- I can explain our design philosophy.

WHAT DO I SAY?

- We have divided things this way: …
- We made sure that our design incorporates the following features…
- We are proud of this part.
- This we like to change/improve over time.

CONSTRUCTION GUIDE

WHAT DO I DO?

- I make sure everybody understands what they are supposed to do.
- I make sure we stay focused on our task.
- I help to divide the work. (I don't command what everybody has to do!)
- I make sure everybody works.

WHAT DO I SAY?

- Who can tell us what we're supposed to do?
- How are we going to handle this?
- Who will do this?
- Come on, let's keep working on this.
- What do you think about this design?

TIME GUARDIAN

WHAT DO I DO?

- I keep track of the time.
- I warn the team if we run out of time.
- I encourage the group to keep working.
- I help to divide tasks due to the time constraints.

WHAT DO I SAY?

- It's almost time!
- We still have … minutes to go.
- We gotta work faster.
- We need to finish this soon.
- We got … for this challenge.

RULE KEEPER

WHAT DO I DO?

- I make sure we don't break the rules.
- I make sure we don't bother the others.
- I got a copy of the rules and the design specifications. (Only the rule master may see these, but he may communicate these to his/her team members.)
- I help my team to stay within the rules of the project.

WHAT DO I SAY?

- We make too much noise. Keep it down, we can't hear each other.
- That design will be discarded if we do that.
- Don't forget we mustn't do that.
- The design specifications are as followed: …

MOTIVATOR

WHAT DO I DO?

- I give people a compliment.
- I encourage people.

WHAT DO I SAY?

- Come on, don't quit. We are almost there.
- Don't give up! We can do this together.
- You really did a good job there.
- Great cooperation everyone.

attachment 2: rules of the workshop

1) There are multiple stages during a production badge. The first stage is a development stage. In the development stage you can test and modify every plane you have folded with your team. The second stage is the judging stage where the work of your team gets used and evaluated.

2) Every person can only fold once in succession. The model then needs to be passed to an adjacent member to perform an next action/fold and so on. An action consists either out of one fold, one cut, one connection with glue et cetera. Every time a group cheats, their model will be discarded.

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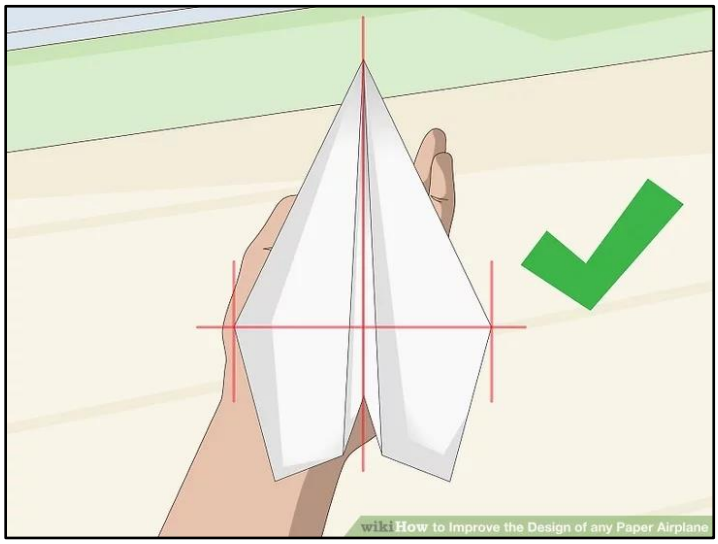
8) Breaking the rules will result in a deduction of points or elimination of prototype planes.

9) This project works with a scoreboard. Points can be earned by gaining points from the judge, completing additional special challenges and by not using a token. At the end of a production badge, the judge will evaluate your design and give it points. Every group gets a token for every production badge. The group can choose to use these tokens for an extra tip. If they don't use it they will receive an additional two points on their score. Badges can also be given for beating the special design challenge of that production badge. For example the plane that flies the furthest, the plane with the longest wing span to bridge a distance of 10 meters.

- **attachment 3: tip sheets from the following website: https://www.wikihow.com/Main-Page**



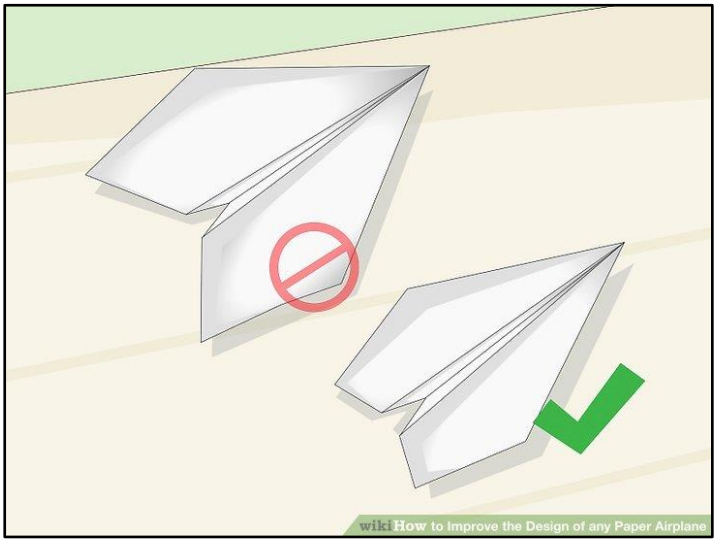
Make sure the wings are symmetrical.

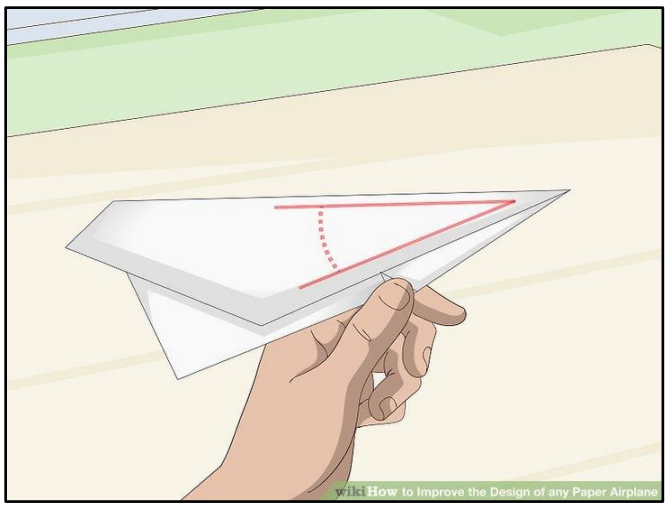
Often, during the process of making folds, you crease the page, make the wing length uneven, and so on. Unfold your plane and refold it again. If there's an extra crease on one side, add it to the other. That way, the wind will hit the plane the same way on both sides.

You can also cut off uneven and excess bits of paper, but this is risky since you won't be able to go back.

Make the wings shorter.

The aspect ratio of the wings affect flight. Long, wide wings are good for gliding but have to be thrown gently. Short, stubby wings are usually better because you can throw the plane faster and angle it more upwards. Refold the wings according to your needs.





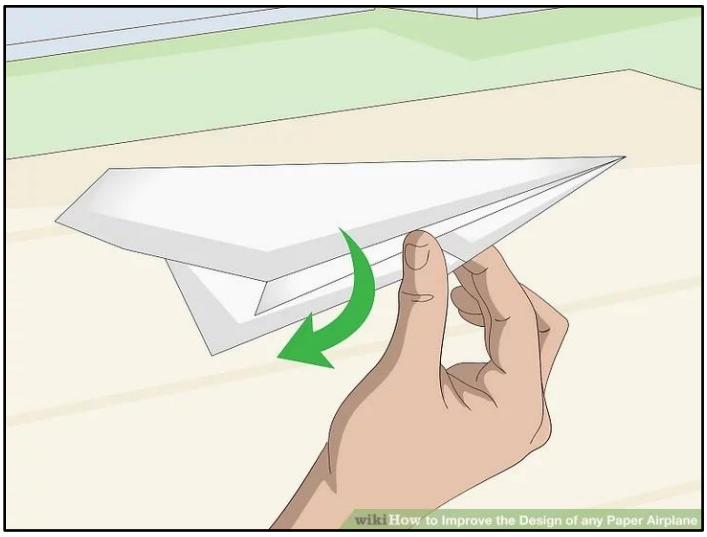
Angle the wings.

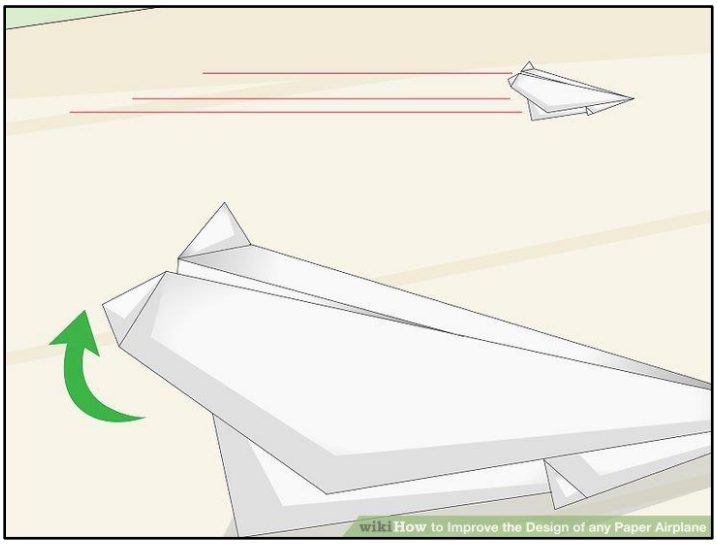
A standard airplane needs wings that point upwards. If your wings are flat or upside down, redo them. Wings angled upwards are called “dihedral” and give your plane stability. Lift the wings upwards so that the wing tips are above the rest of the plane.

Add fins to complicated designs.

Fins are small folds you make on the wings. The paper doubles over itself when you do this. Take the edges of the wings and fold them downwards and over. This is the fin, and the fold should be parallel to the length of the plane. These fins can help stabilize and strengthen some planes.

Fins are useful in more complicated designs. For standard dart planes, they should be avoided since they will slow the plane.





Bend the back end of nosediving planes upwards.

Stable paper airplanes fly farther and faster. Paper airplanes typically benefit from adding what's known as up elevator. Take the back end of the airplane, which on a standard dart-shaped plane is the wing tips, and use your finger to bend them upwards a little.

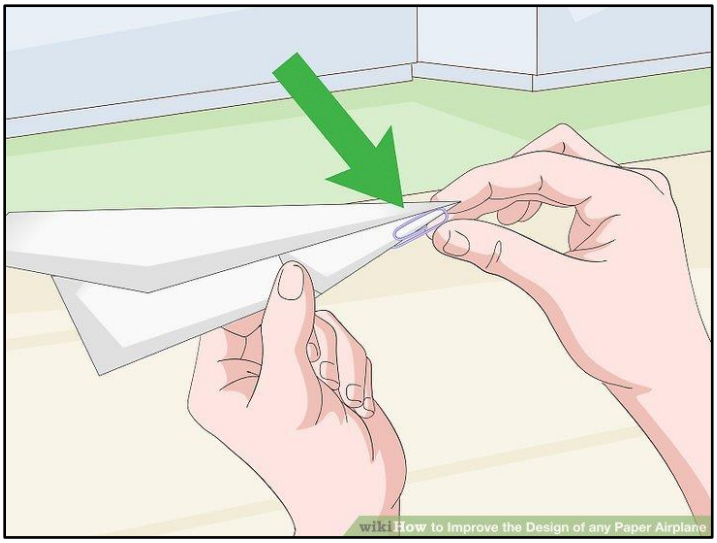
This counterbalances the weight in the nose of your plane.

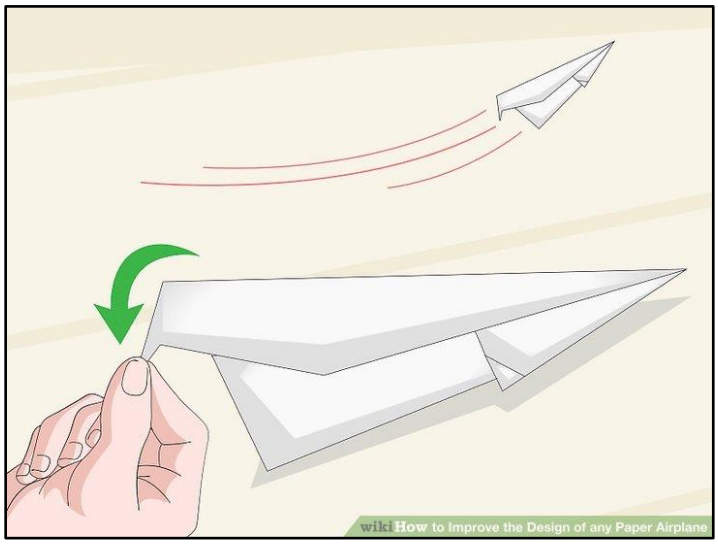
Weigh down the nose on stalling planes.

Most planes also benefit from a little weight in the nose. This helps balance the plane so it doesn't have a tendency to fly straight up. Cover the nose in a layer or two of tape or add a paper clip. Test out out the plane and make adjustments as necessary.

Most airplanes are better off being slightly nose heavy rather than slightly tail heavy.

Heavier planes are better at withstanding outdoor flight.





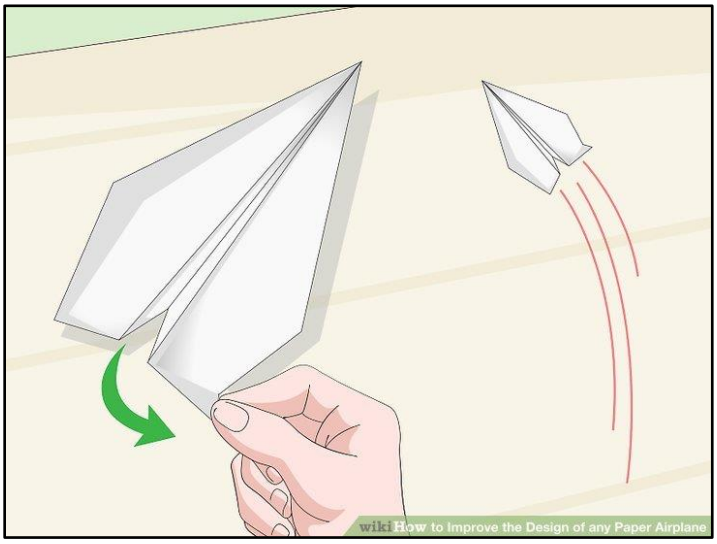
Bend the back ends downwards on stalling planes.

Bending the wing tips downwards is only useful for planes that try to fly upwards when launched. Use your fingers to bend them down slightly. Try throwing the plane again. If this isn't enough to balance it, you can try adding more weight to the nose of the plane.

Bend left-leaning planes to the right.

If your plane has a single, vertical edge for a tail, bend it to the right. Otherwise, pull the right side up and the left side down. These bends will correct the airflow to cause a more stable flight.

The same principal works for right leaning planes but with a bend to the left.



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