# Paper Plane / Paper Glider ～The Fright Time～

Junten High School、Gaku Nagahara, Hiroki Suzuki, Shoma Takemoto, Tong Rui

## Background & Purpose

There are several types of paper planes.For example, Origami airplanes are made by folding a piece of paper and Paper gliders are made by cutting and pasting a piece of paper.
Recently, it is also used in elementary school classes. About the origami airplanes, Takuo Toda who is the chairman of the Japan Origami Hikoki Association set a world record of29.2 seconds in 2010. Paper planes come in many shapes, and the flight time varies depending on the length of the wings and the position of the center of gravity.
With that in mind, we conducted experiments to create paper planes and paper gliders that could fly more longer.

## Research Plan & Result of the study

### Origami Plane

#### *Heso* plane

↑ “Heso”

Contents of the study

・The Heso size →0.5～2.0(cm)

Result

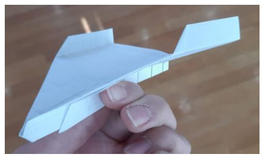
The Heso size and flying time

| "Heso" size (cm) | | 0.5 | 1 | 1.5 | 2 |
|---|---|---|---|---|---|
| Fight time (s) | 1st time | 8.08 | 6.77 | 7.05 | 7.49 |
| | 2nd time | 7.92 | 7.5 | 6.99 | 6.14 |
| | 3rd time | 6.99 | 8.7 | 6.96 | 5.95 |
| | 4th time | 7.32 | 6.55 | 6.07 | 5.76 |
| Average (s) | | 7.58 | 7.38 | 6.77 | 6.34 |
| Variance | | 0.2 | 0.7 | 0.16 | 0.46 |

From the table
When the *Heso* is small, the flight time is long.
The variance value was small and the plane flew most stably of the other paper planes.

The wings became bigger when the *Heso* was made smaller.

#### Sky king



Yellow line; Handle
Red line; Winglet

Contents of the study

・The Length of Handle →1.0, 1.5(cm)
・The Length of Winglet →0.5～ 2.0(cm)

Result

①The length of the Handle

| Handle(cm) | 1 | 1.5 |
|---|---|---|
| 1st time | 3.33 | 4.65 |
| 2nd time | 2.43 | 3.8 |
| 3rd time | 4.77 | 5.86 |
| 4th time | 4.57 | 2.76 |
| Average (s) | 3.78 | 4.27 |
| Variance | 0.91 | 1.29 |

②The length of the Winglet

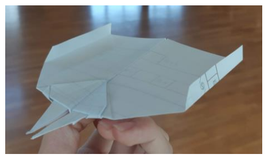
| Winglet(cm) | 0.5 | 1 | 1.5 | 2 |
|---|---|---|---|---|
| 1st time | 2.59 | 4.19 | 3.49 | 2.3 |
| 2nd time | 4.65 | 3.22 | 6.54 | 2.74 |
| 3rd time | 3.23 | 4.44 | 2.12 | 3.05 |
| 4th time | 6.63 | 3.13 | 4.05 | 2.69 |
| Average (s) | 4.28 | 3.75 | 4.05 | 2.7 |
| Variance | 2.4 | 0.33 | 2.56 | 0.07 |

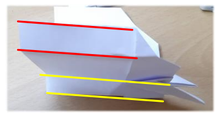
From the table①
To lengthen the handle, the flight time became longer.

From the table②
When the Winglet is small, the flight time is long.

From the table①,②
Some have large variance values and are difficult to compare with other values.

#### *Kuwagata* plane





Yellow line; Handle
Red line; Winglet

Contents of the study

・The Length of Handle →1.0, 1.5(cm)
・The Length of Winglet →1.0, 1.5(cm)

Result

①Winglet(1cm) and Handle

| Winglet 1cm | | |
|---|---|---|
| Handle(cm) | 1 | 1.5 |
| 1st time | 4.71 | 2.51 |
| 2nd time | 4.23 | 6.5 |
| 3rd time | 6.27 | 7.39 |
| 4th time | 5.08 | 6.01 |
| Average (s) | 5.07 | 5.6 |
| Variance | 0.57 | 3.43 |

②Winglet(1.5cm) and Handle

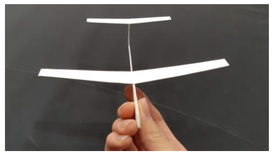
| Winglet 1.5cm | | |
|---|---|---|
| Handle(cm) | 1 | 1.5 |
| 1st time | 2.36 | 4.95 |
| 2nd time | 7.52 | 6.52 |
| 3rd time | 5.34 | 7.41 |
| 4th time | 8.29 | 3.25 |
| Average (s) | 5.88 | 5.53 |
| Variance | 5.29 | 2.51 |

From the table①
When both Winglet and Handle were 1cm, it flew stably.

From the table②
The variance is large, but there is the longest flight time of the all *Origami* plane flight times.
The time is 8.29s

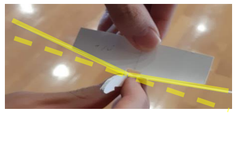
From the table①,②
The variance value was large overall, and the flight time was not stable.

### Paper Glider



Rubber catapult

・The catapult's angle ; 30°
・Length of stretched rubber ; 15 cm



Contents of the study

・The angle of the main wing → -10, 0, 10(° )
・The length of the main wing → -1.0～1.0(cm)
(Based on standard length)

Result

①The angle of the main wing

| Angle(° ) | -10 | 0 | 10 |
|---|---|---|---|
| 1st time(s) | 0.96 | 1.46 | 1.83 |
| 2nd time(s) | 1.03 | 2.11 | 1.29 |
| 3rd time(s) | 1.33 | 1.06 | 1.73 |
| Average(s) | 1.11 | 1.54 | 1.62 |
| Variance | 0.03 | 0.19 | 0.06 |

②The length of the main wing

| Lendth(cm) | -1 | -0.5 | 0 | 0.5 | 1 |
|---|---|---|---|---|---|
| 1st time(s) | 3.4 | 1.43 | 2.5 | 2.8 | 1.1 |
| 2nd time(s) | 2.9 | 1.14 | 1.77 | 3.1 | 1 |
| 3rd time(s) | 3.3 | 1.88 | 2.76 | 3 | 0.5 |
| Average(s) | 3.2 | 1.48 | 2.34 | 2.97 | 0.87 |
| Variance | 0.05 | 0.09 | 0.18 | 0.02 | 0.07 |

From the table①
To increase the angle, the flight time became longer and stable.

From the table②
Longer wing has longer flight time than shorter wing.

From the table①,②
Paper glider set a more stable record than *Origami plane*, but the flight time was smaller than *Origami plane*.

## Future study plan

・Experiment with different angles of tail fins, vertical tail fins.
・Experiment with different molds of the planes.
・Development of a paper planes that can fly for a long time no matter who throws it.
・Break the world record for paper plane flight time.

## References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