



**Hangtime  
optimization  
for a paper airplane**

# Hypothesis

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**Hypothesis:** Wing area has a direct effect on hang time.

**Question:** What is the effect of reducing the wing area on a paper airplane?

# Process



- **Establish a baseline configuration**
- **Modify (incrementally) the baseline design**
  - **Trim wings**
- **Compare performance against baseline**
  - **Measure** Hangtime in seconds
- **Maintain all other parameters Constant**

# Materials required

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- 1 sheet of 8 ½ X 11 sheet of paper
- Pair of scissors
- Ruler
- Stop watch
- 100' tape measure

# Required Experiments



## → Throw for time trials

- Single “pilot” to minimize variability

- 5 trials to establish consistency

- May require deletion of extreme values

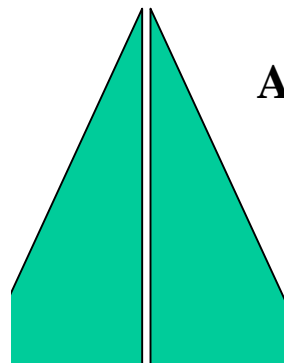
## → Monitor flight duration

- From leaving the pilot’s hand **to**

- Touchdown (first contact)

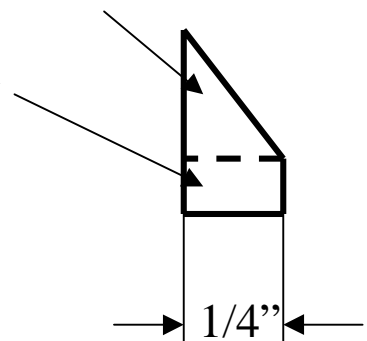
# Procedure

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- Fold a standard delta wing paper airplane
  - Measure the wingspan – tip to base and the root chord (the widest part of the wing) base to tip
  - Calculate the area of both wings (note that the shape removed is basically a triangle on top of a rectangle)
  - Throw 5 times – measuring the time from when it leaves the hand to the time it touches down- **Take average of five throws.**
  - Record each time



$$A = 1/2 * \text{Base} * \text{Height}$$

$$A = \text{Base} * \text{Height}$$



# Wing Modifications



- Using the ruler, measure 1/4" on each wing to “clip” starting at the tip. Both wings must be clipped equally!
- Calculate the area removed from both wings (using the same method as the baseline) and subtract it from the ORIGINAL wing area. This is the wing area for modification #1 (or MOD 1 for short).
- Throw 5 times – measuring the time from when it leaves the hand to the time it touches down
- Record each time. **Take averages of five throws.**
  - Add all cut-offs to plane (so not to change the **total** weight)
- Repeat for five (5) modifications or until the aircraft is too unstable to fly

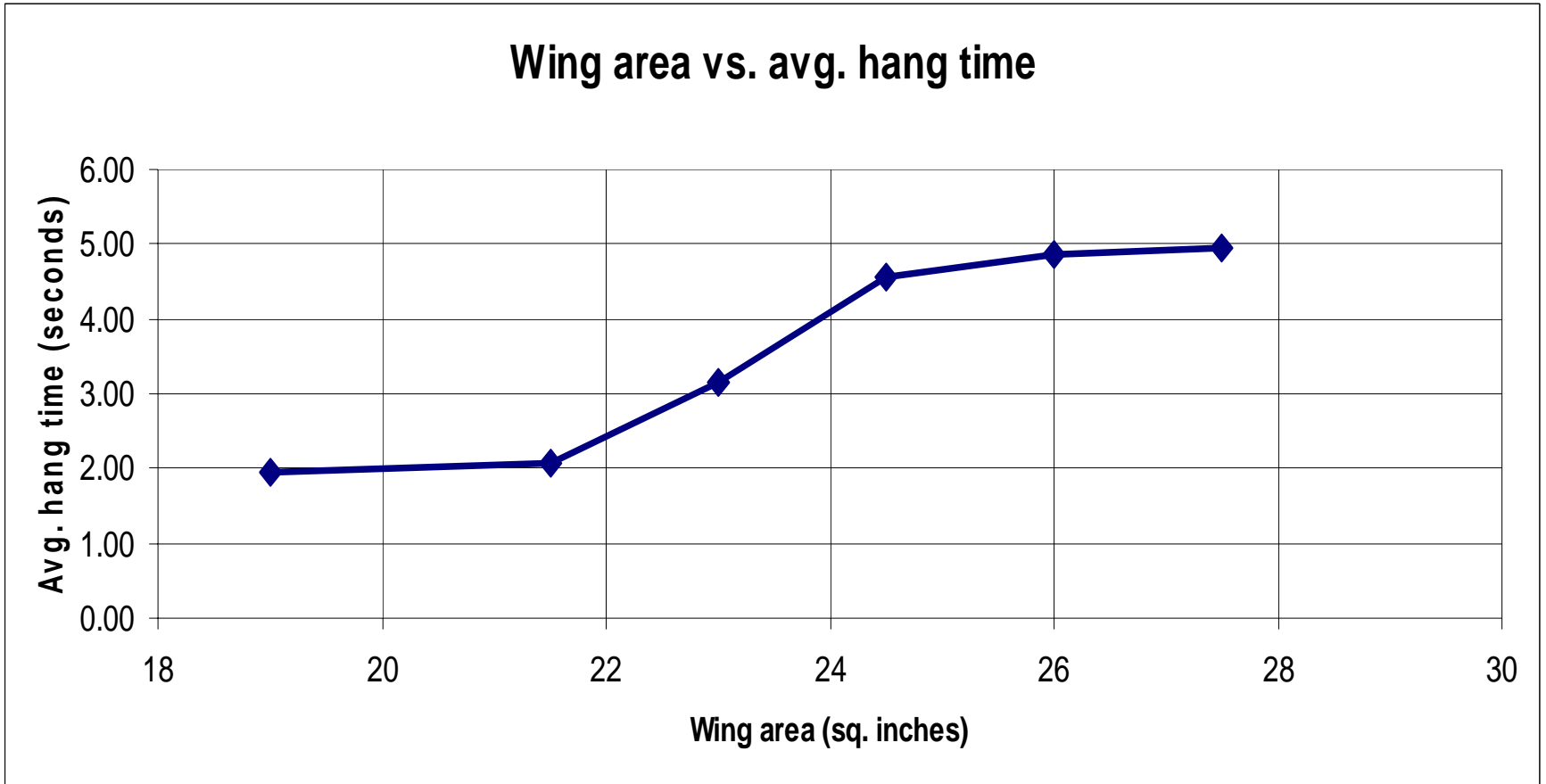
# Results from Time Trials



					Hangtime (seconds)					
	Width (inches)	Height (inches)	Wing area (sq. Inches)	Total wing area (sq. Inches)	Trial #1	Trial #2	Trial #3	Trial #4	Trial #5	Average
Baseline	2.5	11	13.75	27.5	5.00	5.10	4.90	4.80	5.00	4.96
Mod 1	2.25	10.125	13	26	4.90	5.00	4.80	4.70	4.90	4.86
Mod 2	2	9.25	12.25	24.5	4.60	4.70	4.50	4.40	4.60	4.56
Mod 3	1.75	8.375	11.5	23	3.20	3.30	3.10	3.00	3.20	3.16
Mod 4	1.5	7.5	10.75	21.5	2.10	2.20	2.00	1.90	2.10	2.06
Mod 5	1.25	6.625	9.5	19	2.00	2.10	1.90	1.80	2.00	1.96

“Sample data and format”

# Data plot



# Conclusions



**Based on the data, it is inferred that there is a non-linear increase in hangtime with respect to increased wing area.**

**Furthermore, it is also inferred that there is an optimum wing area for this particular configuration, where increasing the area produces very little hangtime gain.**