



**Hangtime
optimization
for a paper airplane**

Hypothesis



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

- 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

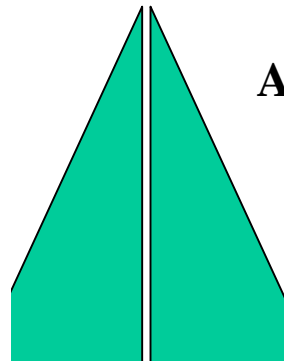
→ Monitor flight duration

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

→ Touchdown (first contact)

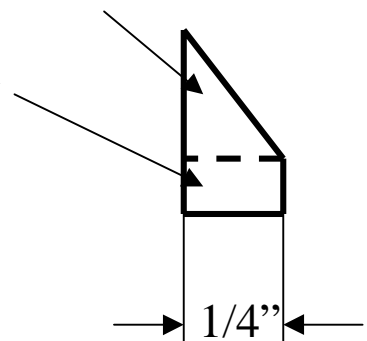
Procedure

-
- 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



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

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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

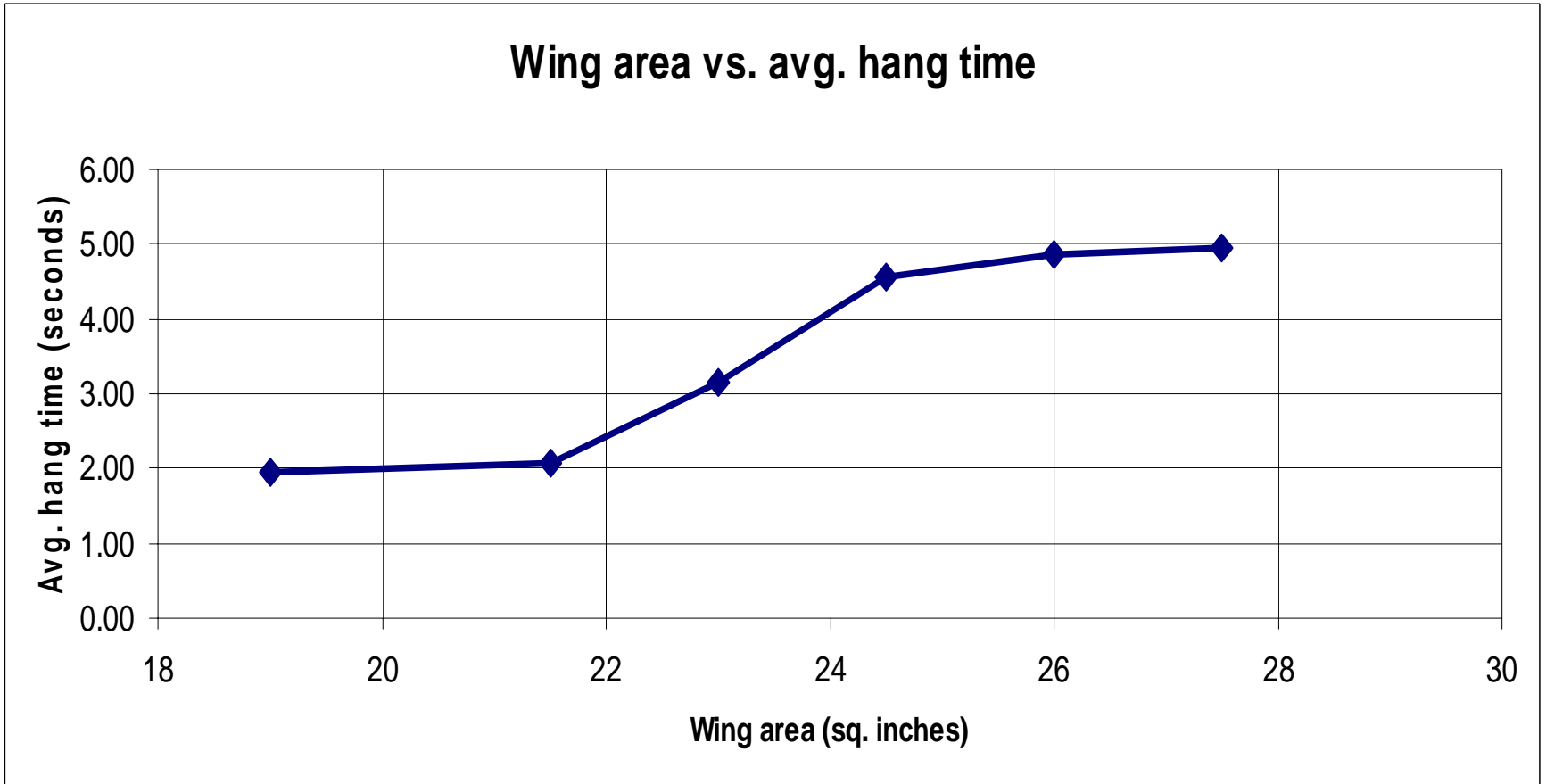
Results from Time Trials



					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.