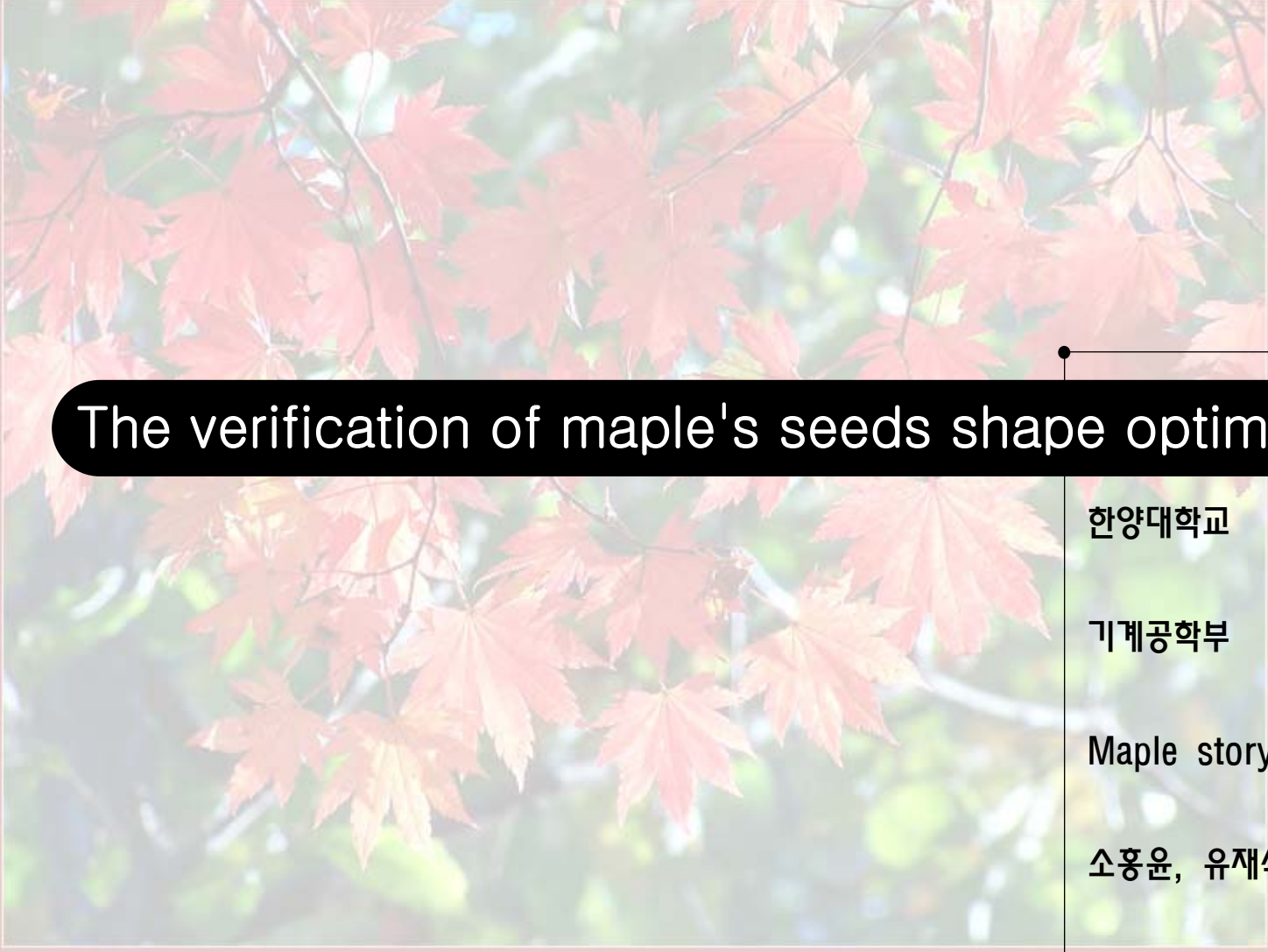




The verification of maple's seeds shape optimized.

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Maple story

소홍윤, 유재석, 고영관

➤ Step1 : Project/Problem Statement

- 식물은 씨앗을 퍼트리기 위해 많은 형태를 가지고 있음.

ex) 도깨비 풀, 포자, 무궁화 꽃, 민들레, 단풍나무

- 바람에 의해 종자를 퍼트리는 대표적인 식물은 민들레, 단풍나무가 있음
- 단풍나무의 씨가 자연에 의해 최적화되었다고 가정
- 모델링을 통해 단풍나무 씨의 최적화 모양 검증

➤ Step2 : Data and information collection

Eqns. : $L = \frac{1}{2} \rho V^2 A C_L$

$$AR(\text{aspect ratio}) = \frac{b}{c} \approx \frac{b^2}{S}$$

Attack angle (받음각)

$$\beta = \frac{\pi}{2} - \alpha = \frac{\alpha_0}{1 + \left(\frac{\alpha_0}{\pi AR}\right)(1 + \tau)}$$

τ : Fourier coefficient (0.05 ~ 0.25)

Parameters :

$$t \text{ (두께)} = 0.4 \text{ mm}$$

$$w = 4 \text{ mm}$$

$$\rho_{\text{air}} = 1.2 \times 10^{-6} \text{ g / mm}^3$$

$$\rho_{\text{maple}} = 15 \times 10^{-5} \text{ g / mm}^3$$

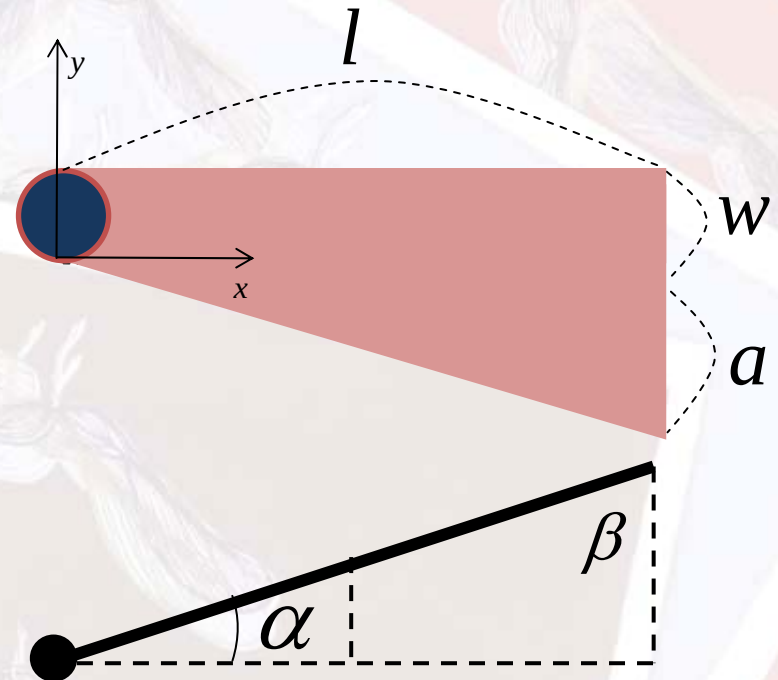
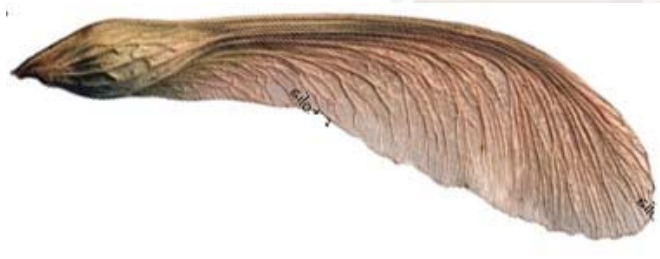
$$\alpha_0 = 0.083553 \quad : (\text{양력 기울기} = \frac{dC_l}{d\alpha})$$

$$m = 0.03 \text{ g}$$

➤ Step3 : Identification/Definition

a : 씨앗으로부터 날개 끝까지의 $-y$ 방향의 길이

l : 씨앗으로부터 $+x$ 방향 길이



➤ Step4 : Identification of a Criterion to Be Optimized

Minimize : $V_{final} = f(a, l)$

종단속도: V_{final}

$$mg = \frac{1}{2} \rho V^2 AC_L \quad : \quad \text{양력} = \text{중력 (종단속도 : 등속도)}$$

$$\xrightarrow{V \text{에 대해 정리하면}} V_{final} = \sqrt{\frac{2mg}{\rho_{air} AC_L}} = \sqrt{\frac{2g \rho_{maple} (w + \frac{a}{2}) tl}{\rho_{air} \pi l^2 \cos \alpha \times C_L}}$$

Attack angle(x)	$C_L(y)$
2.2	0.18
6	0.5
12	1.0
15	1.25

$$\xrightarrow{\text{최소자승법}} y = 0.083553x - 0.002768$$

➤ Step5 : Identification of Constraints

$$\bullet g1 = \frac{l}{w + \frac{a}{2}} \geq 5.5 \quad \Rightarrow \quad 5.5w + 2.75a - l \leq 0$$

$$\bullet g2 = -6 \times m + \rho_{\text{maple}} \text{tal} \leq 0$$

$$\bullet g3 = w\rho_{\text{maple}} \text{tl} + \frac{\rho_{\text{maple}} \text{tal}}{2} - m \leq 0$$

$$\bullet g4 = a \geq 0 \quad \Rightarrow \quad -a \leq 0$$

$$\bullet g5 = l \geq 0 \quad \Rightarrow \quad -l \leq 0$$

a값에 따른 l 값의 변화

