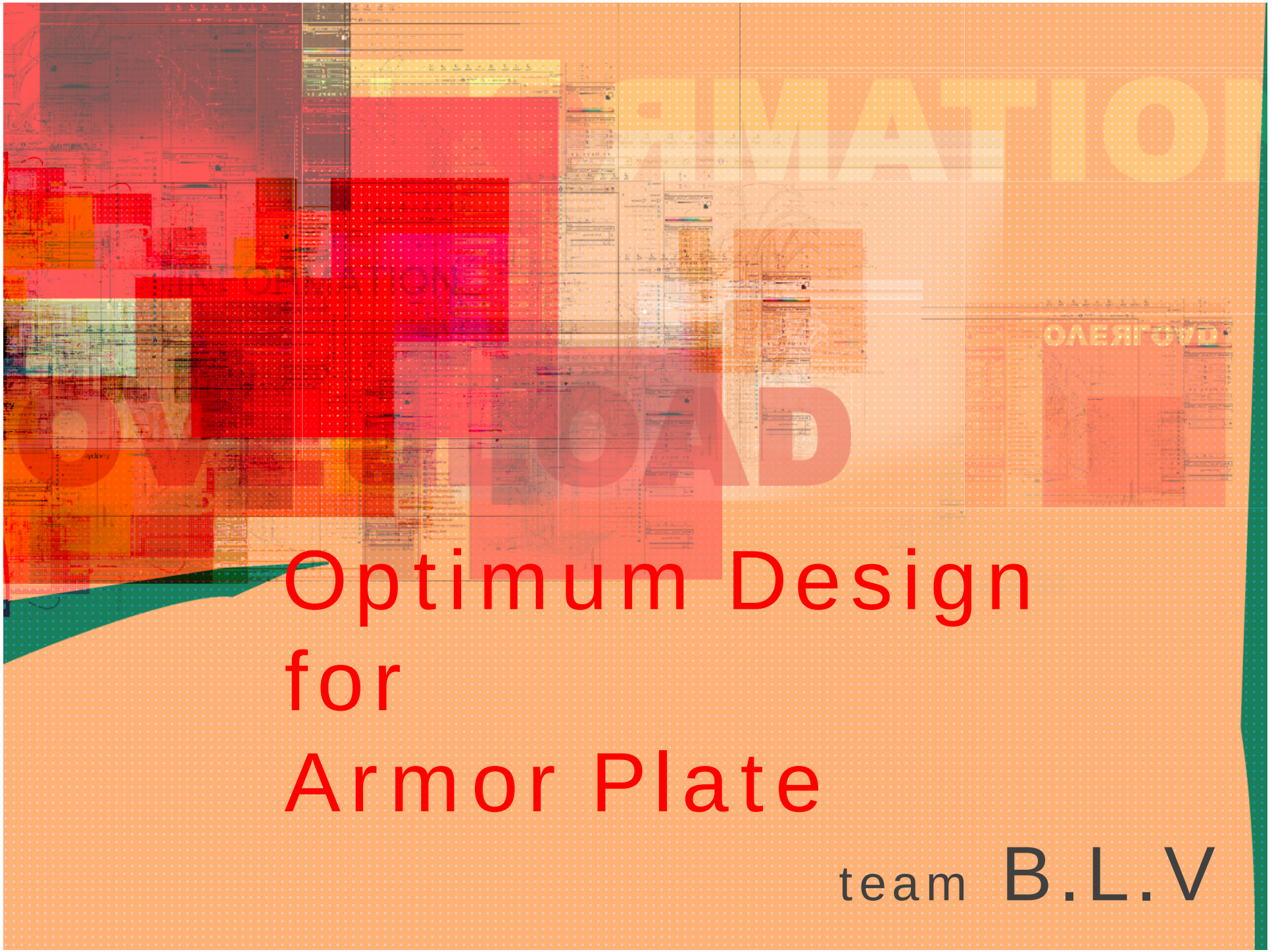
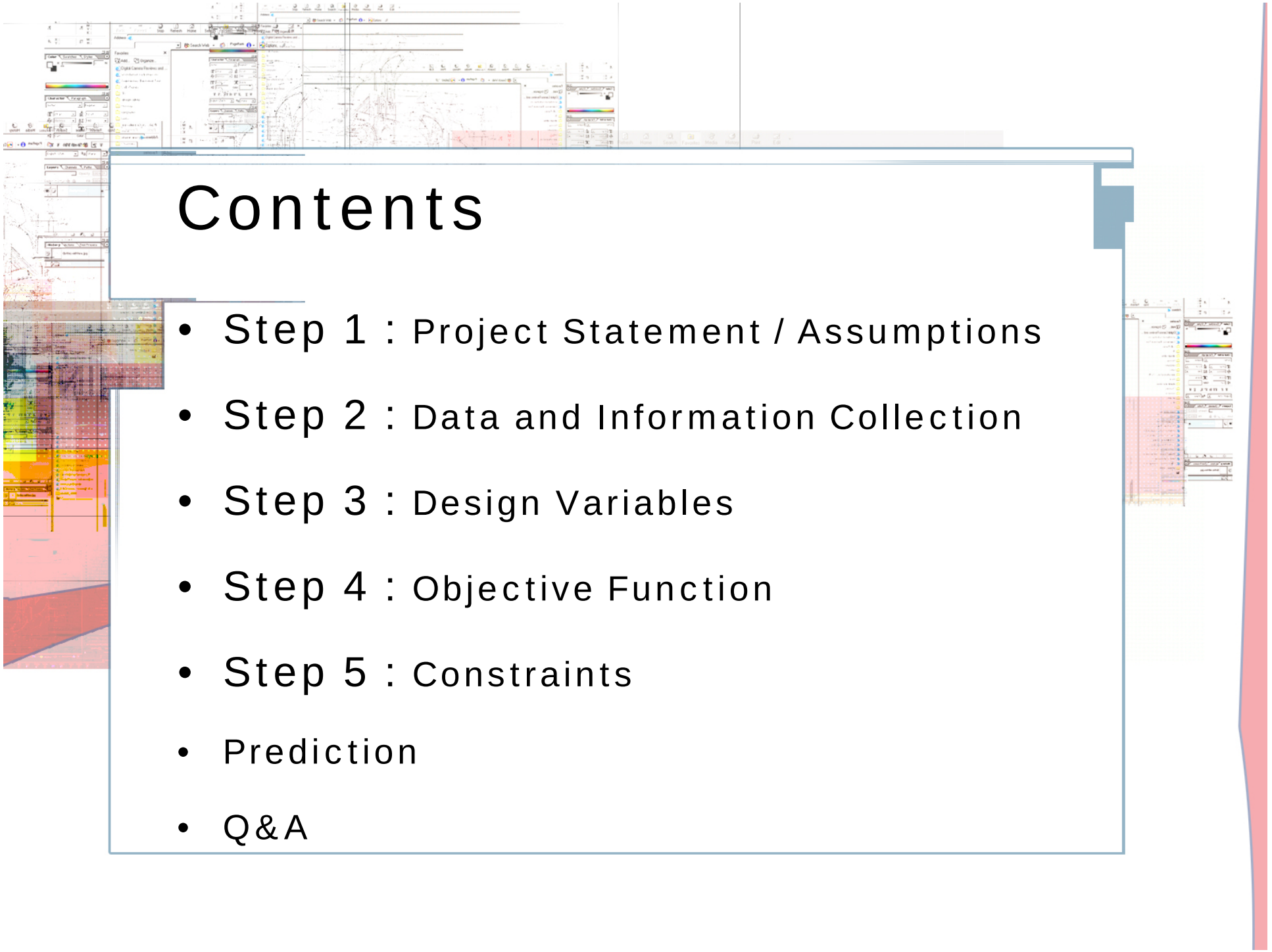


Optimum Design for Armor Plate

team B.L.V



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Step 1 : Project Statement

Object : 자동차에 설치 가능한 장갑판 설계

Requirement :

_700㎧로 날아오는 지름 7.62㎜의 24g 총알을 막아낼 수 있도록 한다.

_알루미늄과 세라믹의 복합구조로 설계한다.

_최소한의 질량을 갖도록 한다.

Assumptions

가정1_종알은 실린더의 형태를 하고 있다고 가정한다.

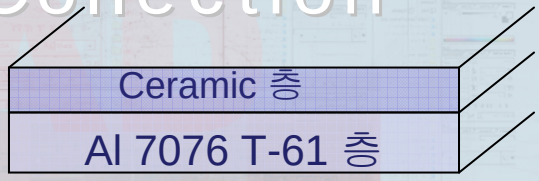
가정2_종알이 장갑판에 수직으로 맞을 때를 고려한다.

가정3_관통 제한 속도(BLV)에 관한 이론으로 Florence 모델을 사용할 것이다.

가정4_장갑판은 무한평판이라고 가정하고, 장갑판의 무게를 계산할 때에는 가로 10㎝ 세로 10㎝의 단위 면적당 무게를 계산한다.

Step 2 : Data and Information Collection

Armor Plate

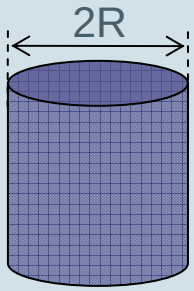


Materials	Density (g/cc)	Elongation at Break	Tensile Strength Ultimate (MPa)
Ceramic	3.96	-	300
Al 7076 T-61	7.845	0.14	510

총알

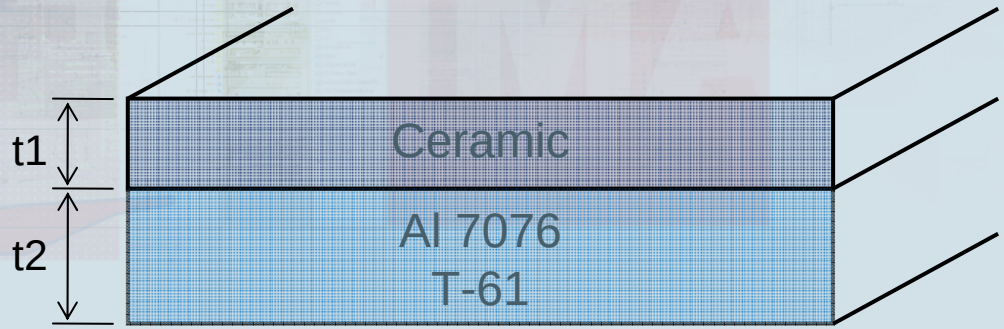
2R=7.62mm

Mass=24g



Step 3 : Design Variables

Design Variables : 각 판의 두께 t1, t2



Step 4 : Objective Function

Objective Function : Mass of Armor Plate

$$m = \gamma_1 A t_1 + \gamma_2 A t_2$$

$$\gamma_1 = 3.96\, g/cc$$

$$\gamma_2 = 2.84\, g/cc$$

$$A = 10\, cm \times 10\, cm = 100\, cm^2$$

Step 5 : Constraints

Thickness of each plate

Thickness of ceramic plate $t_1 \geq 0$

Thickness of aluminum plate $t_2 \geq 0$

BLV equation from Florence's model

$$v_{bl}^2 = \frac{\alpha \epsilon_2 \sigma_2 b_2 z\left[(\gamma_1 b_1 + \gamma_2 b_2)z + m\right]}{0.91\, m^2}$$

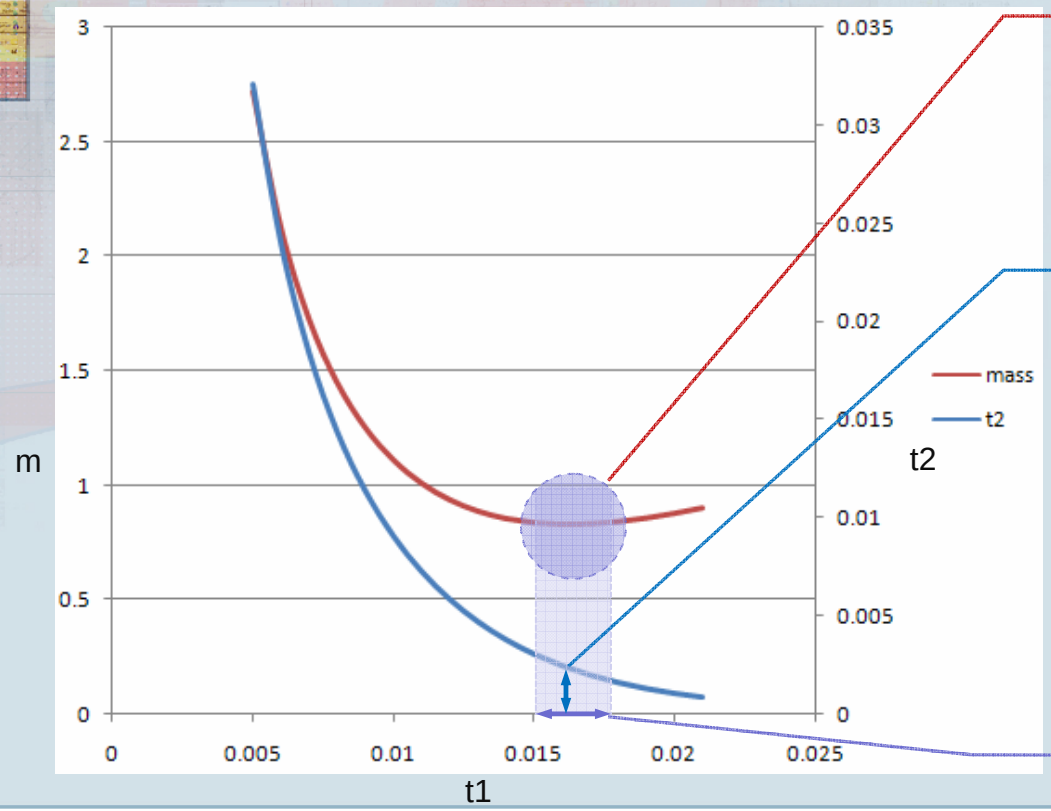
$z = \pi(R + 2b_1)^2$

$\alpha = 1$

$v_{bl} = 700\, m/s$

$$(700\, m/s)^2 \leq \frac{\alpha \epsilon_2 \sigma_2 b_2 z\left[(\gamma_1 b_1 + \gamma_2 b_2)z + m\right]}{0.91 m^2}$$

Prediction



질량이
최소화되는 지점

알루미늄 두께
예상 범위
1mm<t2<4mm

세라믹의 두께
예상 범위
15mm<t1<18mm

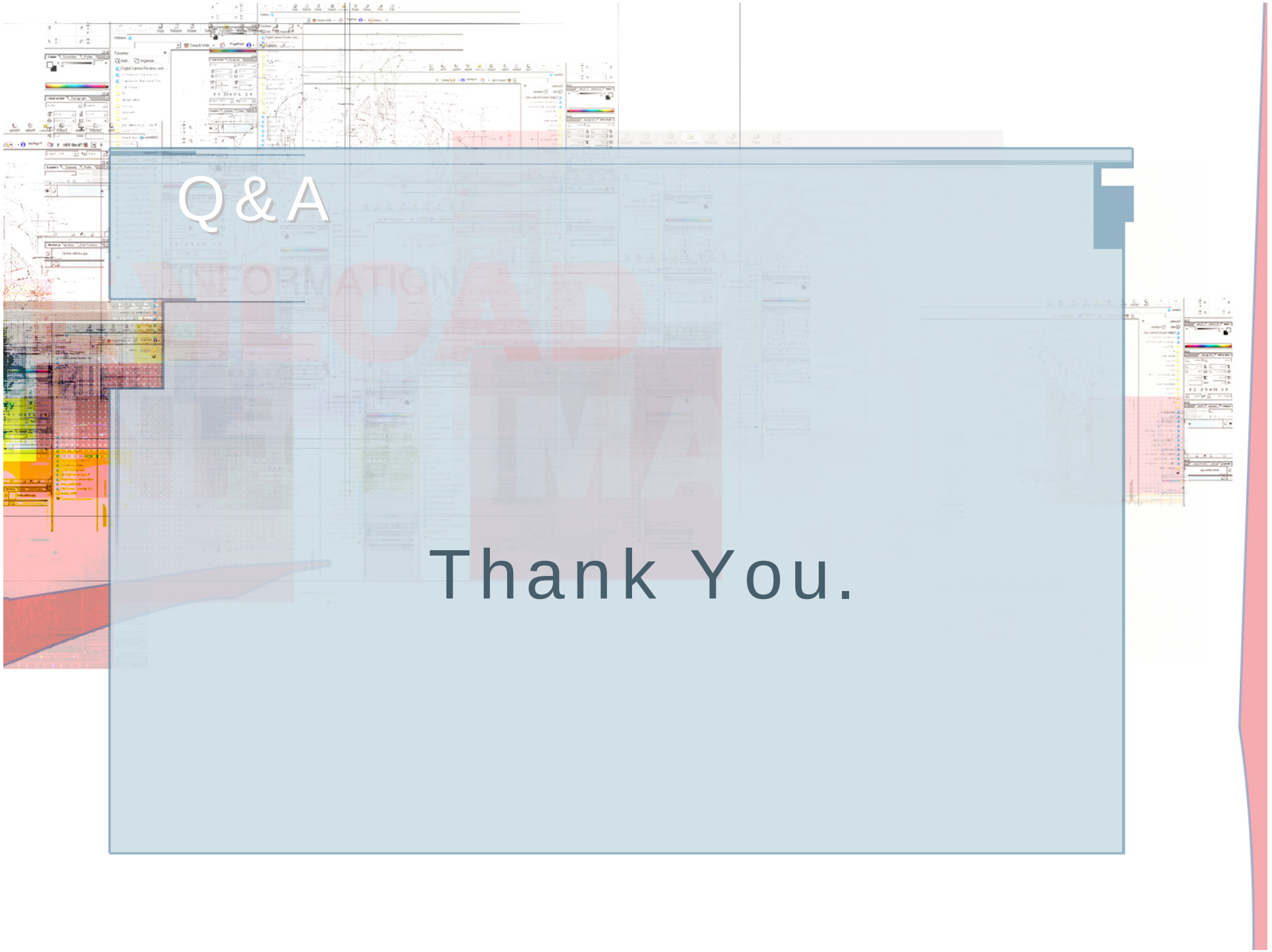
Reference

[1] Ben-Dor G, Dubinsky A, Elperin T, Frage N. Optimization of two component ceramic armor for a given impact velocity. Theor ApplFract Mech 2000.

[2] Ben-Dor G, Dubinsky A, Elperin T. Improved Florence model and optimization of two-component armor against single impact or two impacts.

[3] Mustafa Ubeyli, R. Orhan Yildirim, Bilgehan Ogel. On the comparison of the ballistic performance of steel and laminated composite armors.

[4] http://www.matweb.com/


Q&A
Thank You.