

Progettazione di Materiali e Processi

Modulo 1 – Lezione 3

Progettazione e selezione di materiali e processi

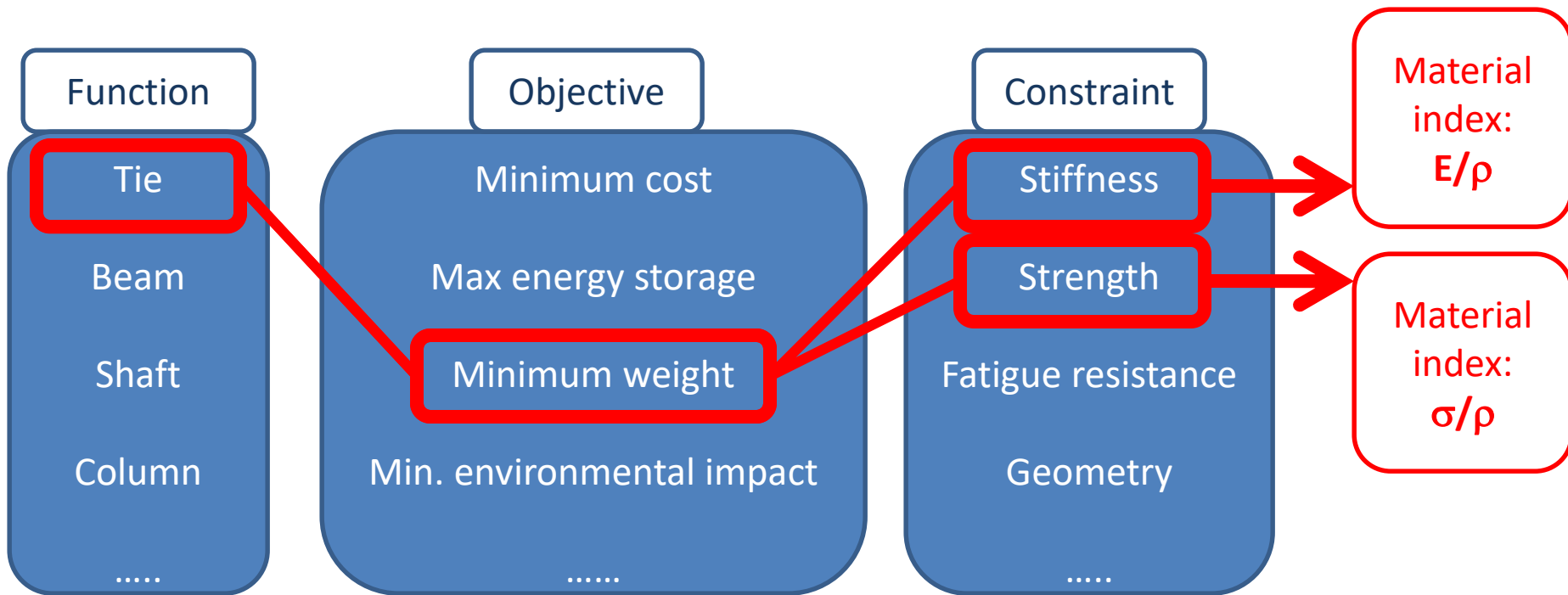
A.A. 2021-22

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Design With Multiple Constraints

Objective limited by one constraint (i.e. what we have been doing so far)



$$m = \rho A L$$

$$m = (\rho/E) S^* L^2$$

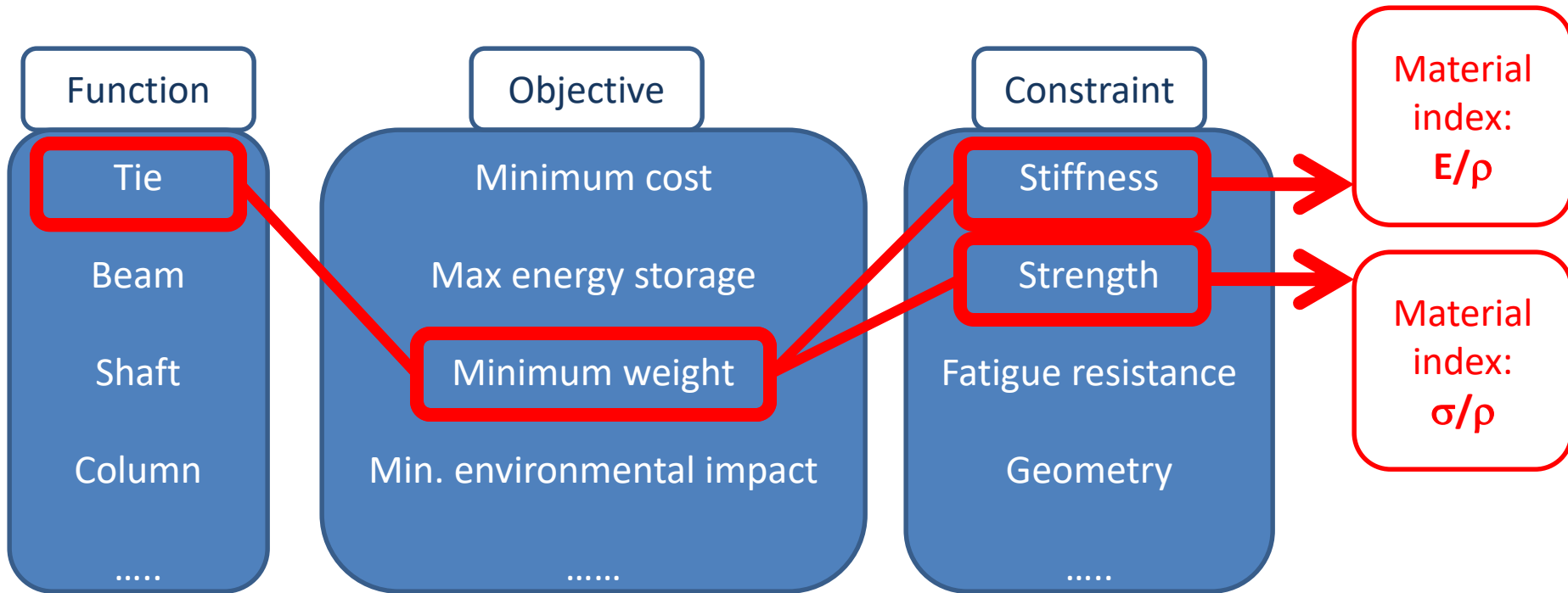
$$m = (\rho/\sigma) L F^*$$

constraint: Stiffness S^*

constraint: collapse force F^*

Design With Multiple Constraints

Objective limited by **two or more constraints simultaneously**



$$m = \rho A L$$
$$m = (\rho/E) S^* L^2 \quad (\text{constraint: Stiffness } S^*)$$
$$m = (\rho/\sigma) L F^* \quad (\text{constraint: collapse force } F^*)$$

Need to select the maximum of the two

Design With Multiple Constraints

Objective limited by **two or more constraints simultaneously** - Example

$$L = 1 \text{ m}$$

$$S^* = 3 \cdot 10^7 \text{ N/m}$$

$$F^* = 10^5 \text{ N}$$

Material	Density (kg/m ³)	E (GPa)	σ_y (MPa)	mass (kg) stiffness constraint	mass (kg) strength constraint	Min mass (kg)
1020 steel	7850	200	320	1.12	2.45	2.45
6061 Al	2700	70	120	1.16	2.25	2.25
Ti-6-4	4400	115	950	1.15	0.46	1.15

$$m = \rho A L \begin{cases} m = (\rho/E) S^* L^2 & \text{(constraint: Stiffness } S^*) \\ m = (\rho/\sigma) L F^* & \text{(constraint: collapse force } F^*) \end{cases}$$

Need to select the maximum of the two

Design With Multiple Constraints

Objective limited by **two or more constraints simultaneously**

Excercise: What if

$$L = 3 \text{ m}$$

$$S^* = 3 \cdot 10^8 \text{ N/m}$$

$$F^* = 3 \cdot 10^4 \text{ N}$$

Material	Density (kg/m ³)	E (GPa)	σ_y (MPa)	mass (kg) stiffness constraint	mass (kg) strength constraint	Min mass (kg)
1020 steel	7850	200	320	106	2.2	106
6061 Al	2700	70	120	104	2.0	104
Ti-6-4	4400	115	950	103	0.4	103

$$m = \rho A L \begin{cases} m = (\rho/E) S^* L^2 \\ m = (\rho/\sigma) L F^* \end{cases}$$

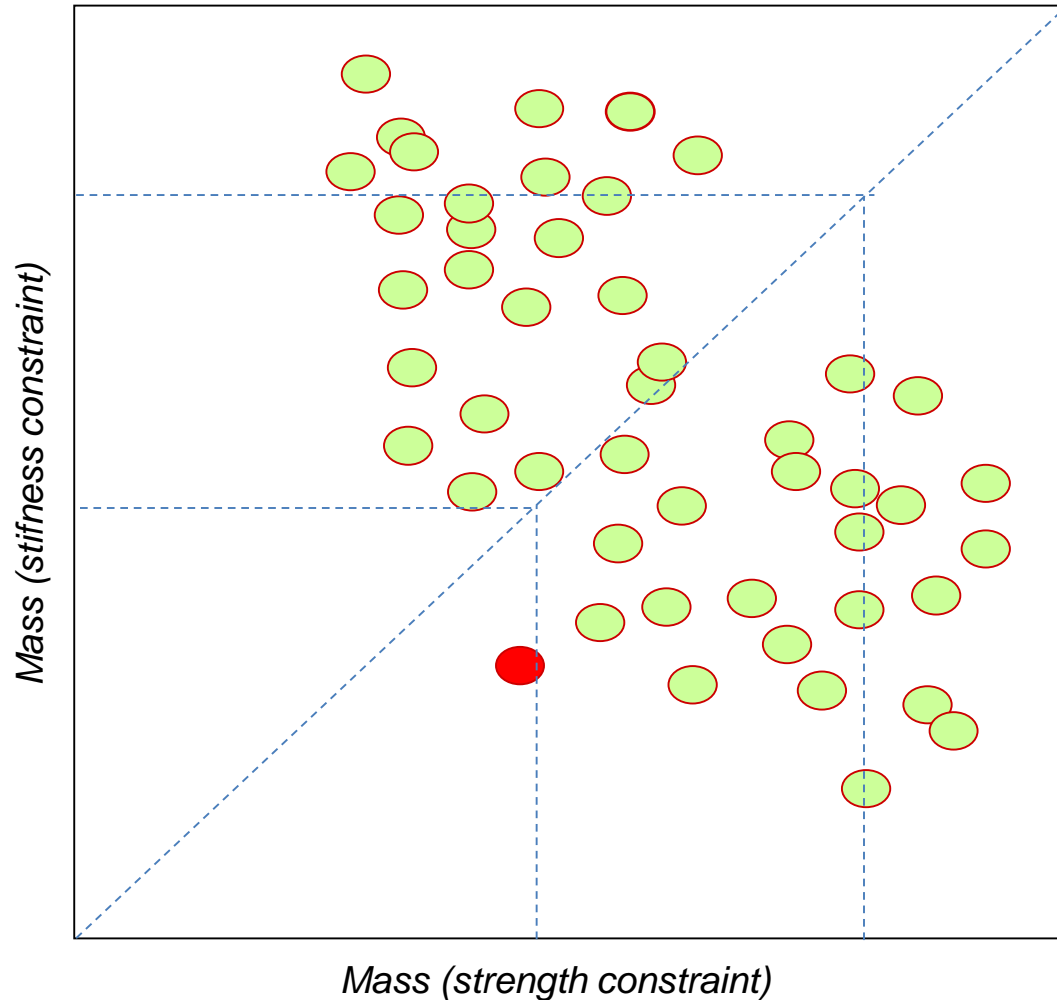
constraint: Stiffness S^*

constraint: collapse force F^*

Need to select the maximum of the two

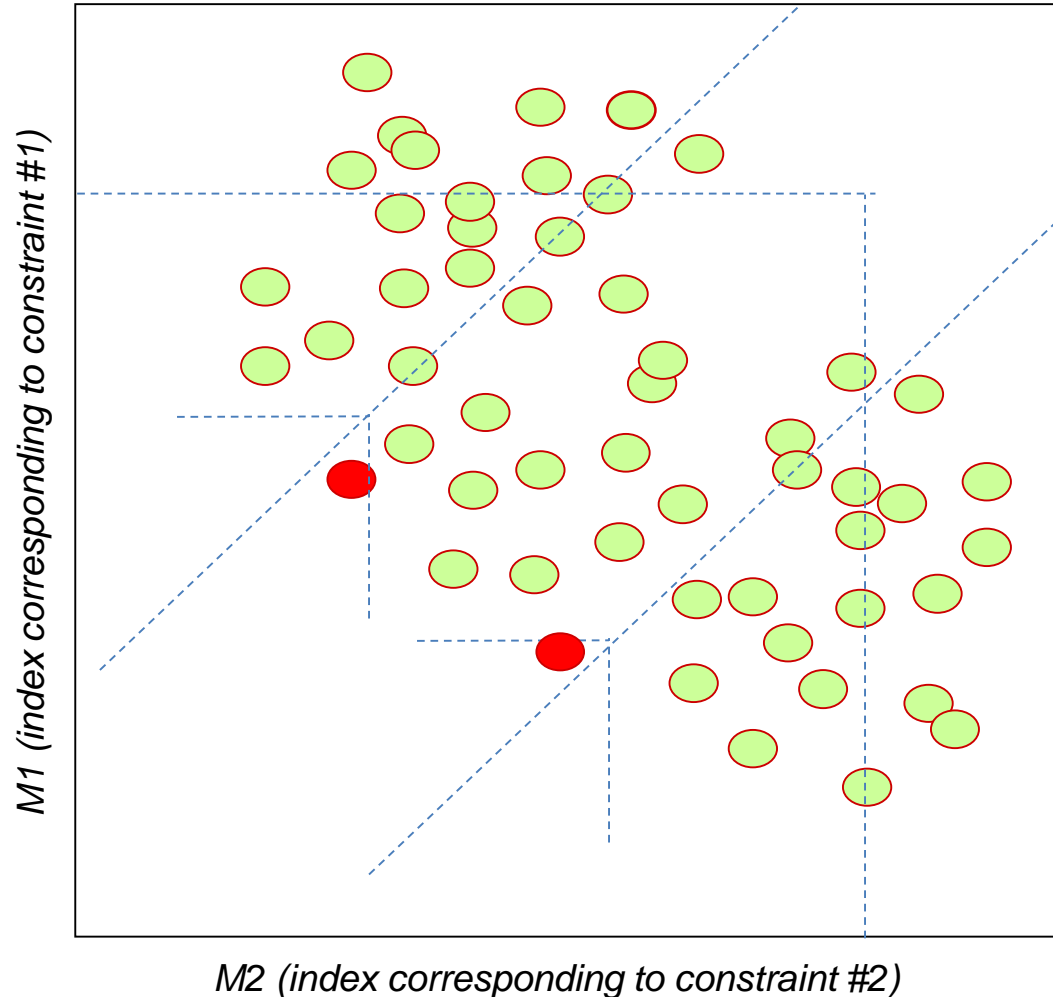
Design With Multiple Constraints

Objective limited by **two or more constraints simultaneously** – graphical method

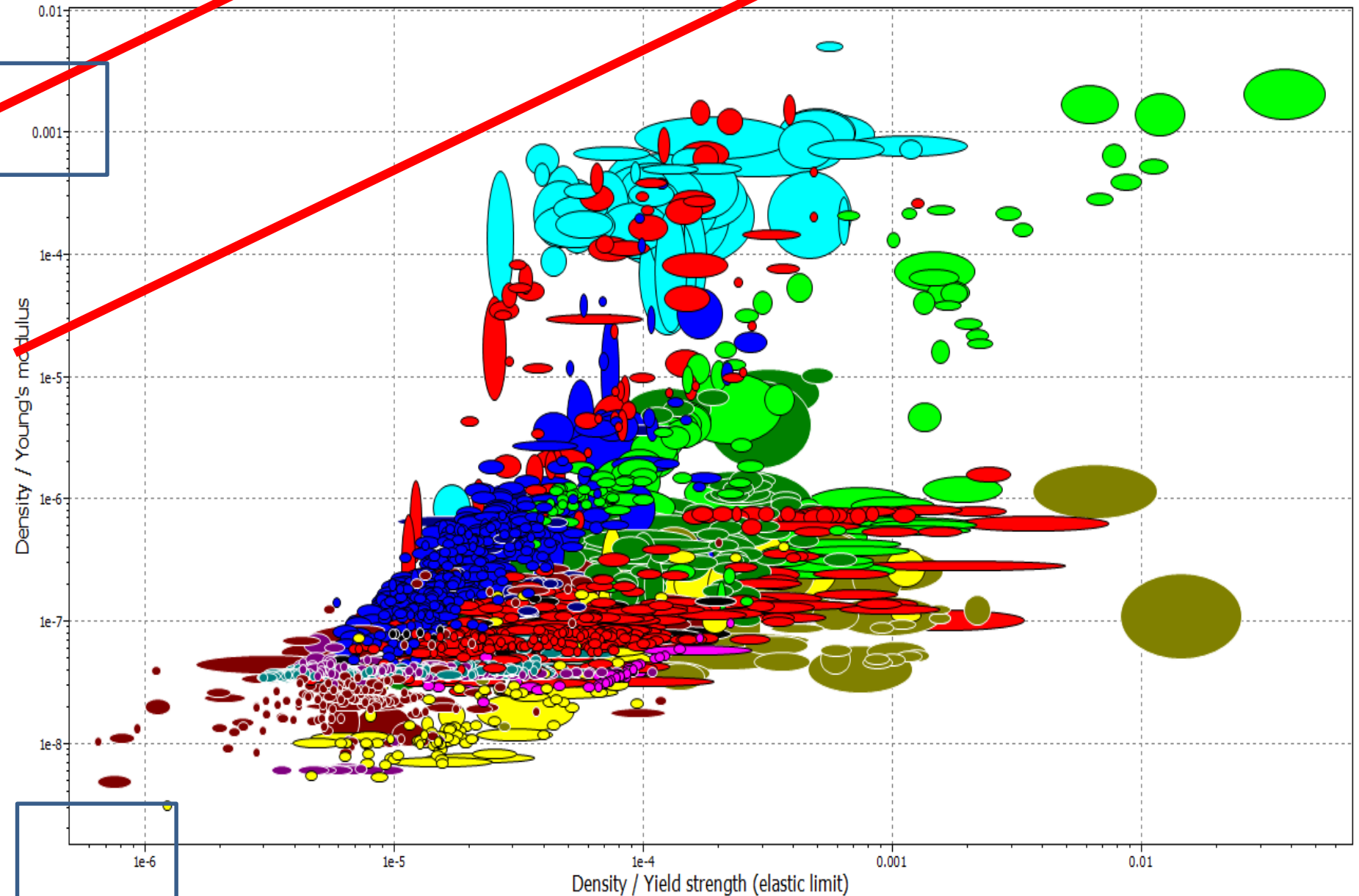


Design With Multiple Constraints

Objective limited by **two or more constraints simultaneously** – graphical method



Design With Multiple Constraints



Design With Multiple Constraints

Example of light pressure vessels

