Università degli Studi di Padova – Dipartimento di Ingegneria Industriale

Corso di Laurea in Ingegneria Meccanica

Relazione per la prova finale «Modellazione FEM e ottimizzazione topologica di un bilanciere per le sospensioni di una vettura da competizione»

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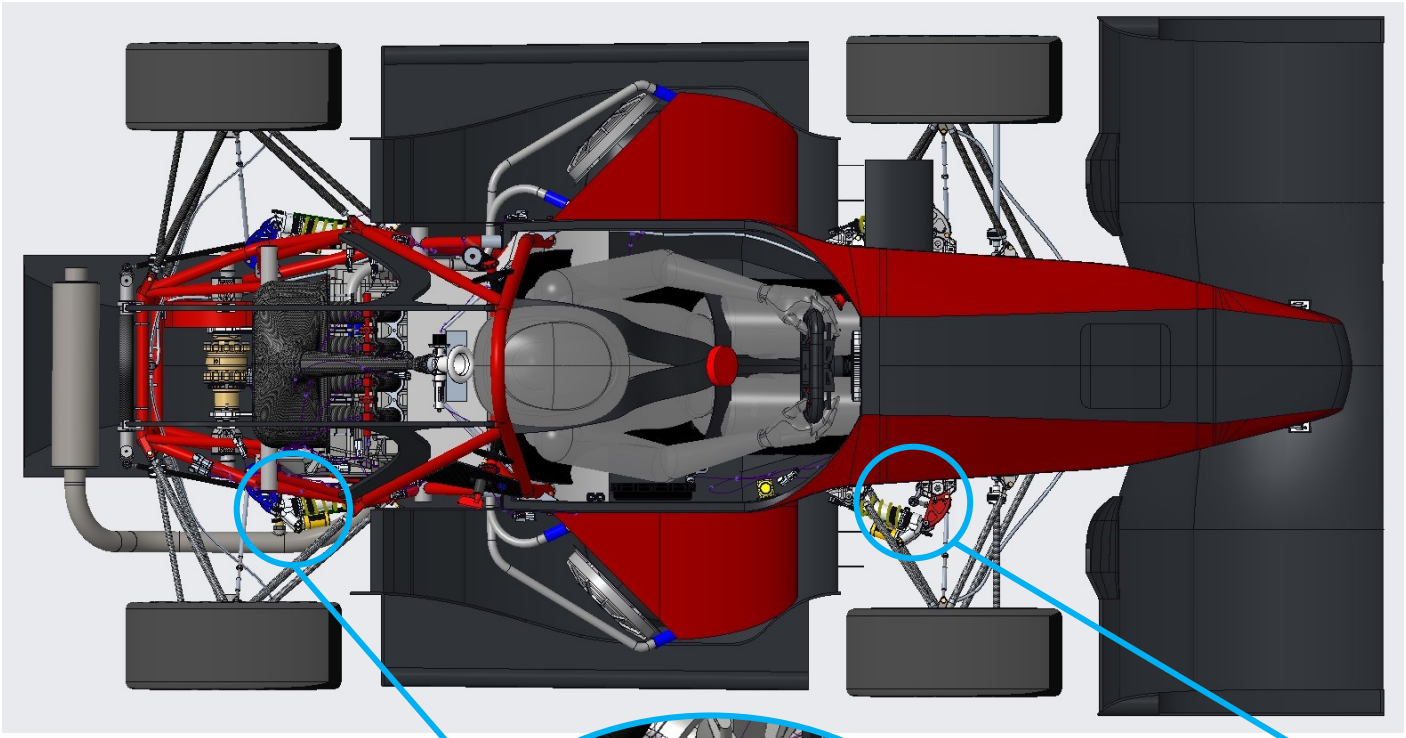
Laureando*: Zeno Pogacnik, 1190193*

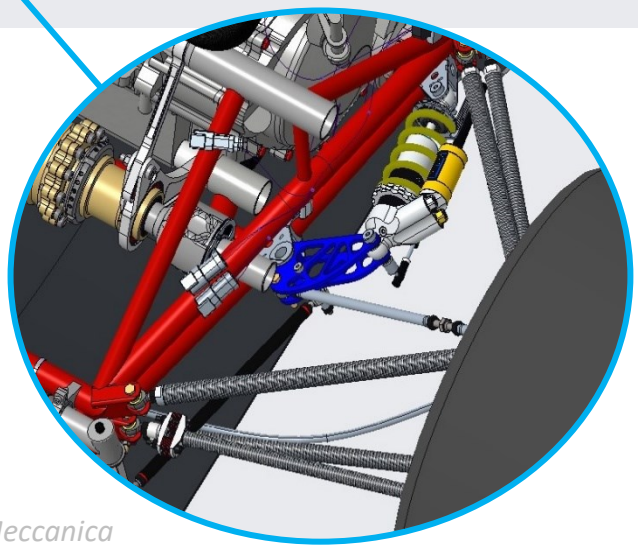
Padova, 08/03/2023

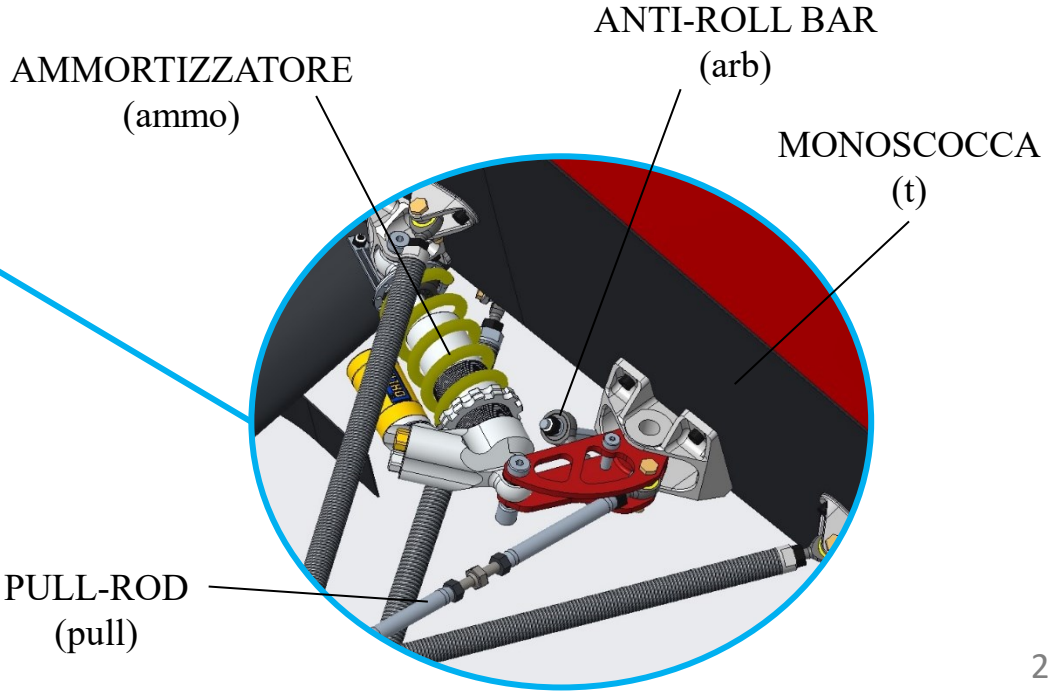
PRESENTAZIONE COMPONENTE E OBIETTIVI



OBIETTIVI:

- Massimizzazione della **RIGIDEZZA**.
- Minimizzazione **MASSA**.
- Rispettare nuovi **INGOMBRI**.
- Geometria realizzabile per asportazione di truciolo.

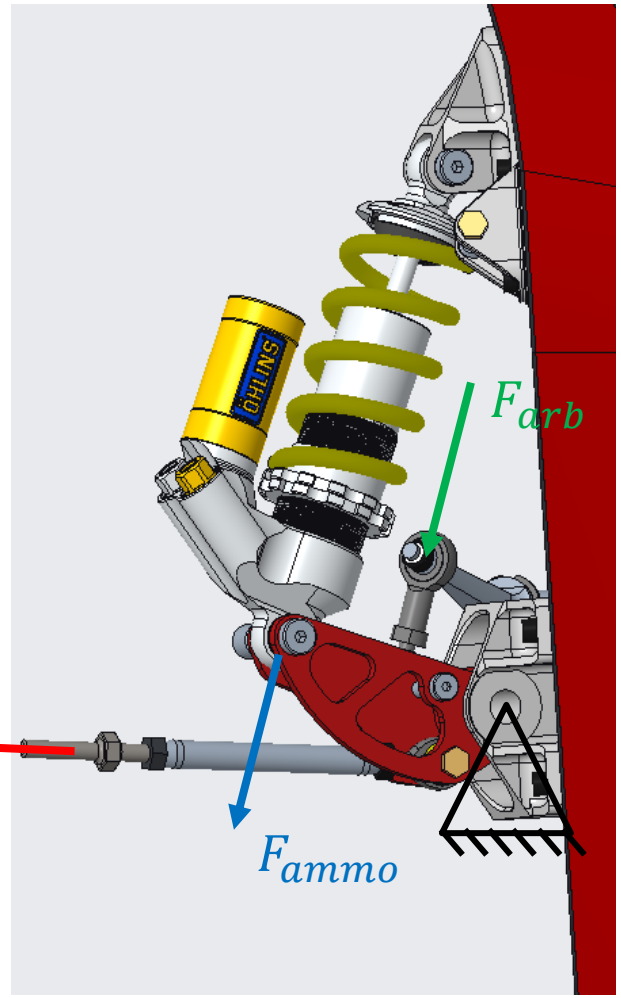




ITER PROGETTUALE:

- Determinazione **FORZE** agenti e le loro componenti.
- Definizione **DESIGN SPACE**.
- Modellazione **MESH**.
- Impostazione delle **BC** per i vari **CASI STUDIO** e dei **PARAMETRI** di ottimizzazione.
- **SOVRAPPOSIZIONE** risultati al CAD e definizione nuova geometria.
- Ultima analisi **FEM** per valutare spostamenti e stato di tensione.

BCs E CASI STUDIO



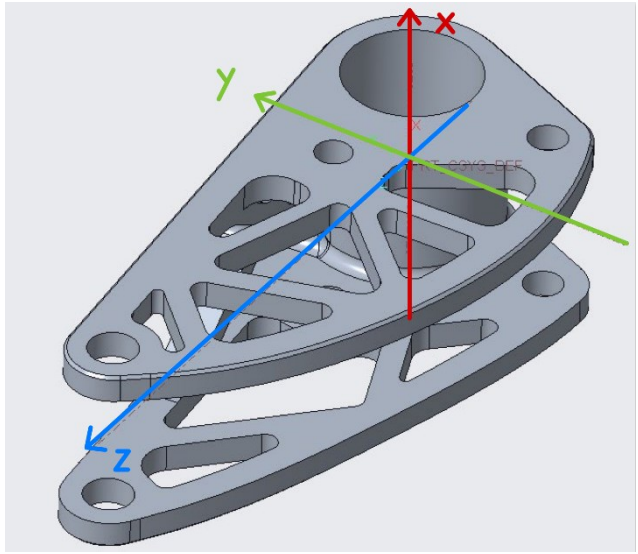
➢ Carichi con max latg= 2,4 g:

	F_{ammo} [N]	F_{arb} [N]	F_{pull} [N]
Anteriore	920	2200	9500
Posteriore	1350	2200	8500

➢ Componenti delle forze:

Anteriore	F_{ammo} [N]	F_{arb} [N]	F_{pull} [N]
F_x	0	-286.26	309.55
F_y	-913.42	-2114.98	-4063.80
F_z	-104.81	-533.79	8578.05

Posteriore	F_{ammo} [N]	F_{arb} [N]	F_{pull} [N]
F_x	0	-137.60	270.85
F_y	1315.96	-1841.87	4256.04
F_z	-301.68	1195.21	7352.72



➢ Casi studio:

	Vincoli	Sollecitazioni
t_{ammo}	telaio; ammortizzatore	pull; arb
t_{arb}	telaio; arb	pull; ammortizzatore
t_{pull}	telaio; pull	arb; ammortizzatore

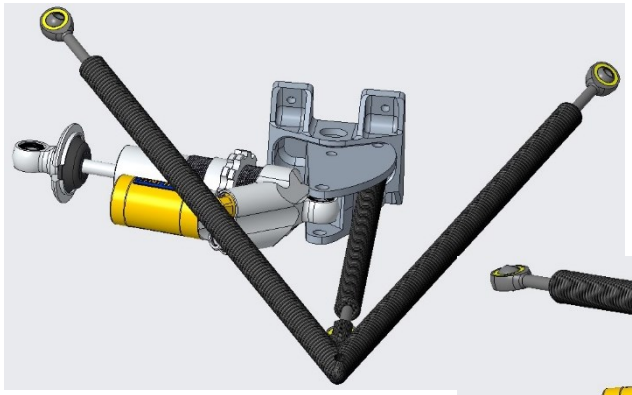
Tipologie vincoli considerati:

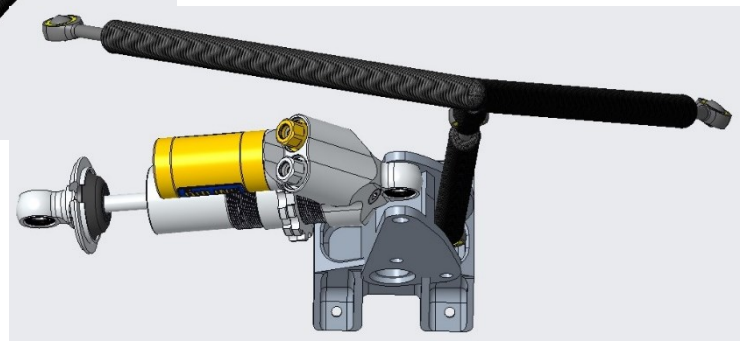
- Ammo e t: cilindrico
- Arb e Pull: sferico

➢ Materiale:

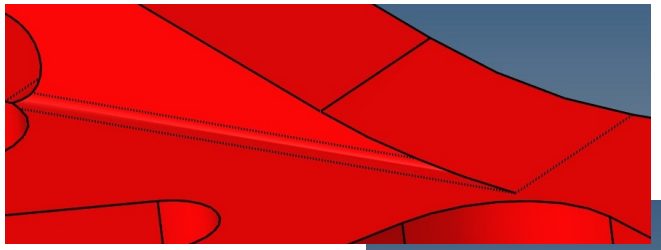
	Ergal
Modulo elastico: (E) [MPa]	72000
Modulo di taglio: (G) [MPa]	27000
Coeff. di Poisson: (ν) []	0.33
Densità: (ρ) [ton/mm^3]	2.81×10^{-9}

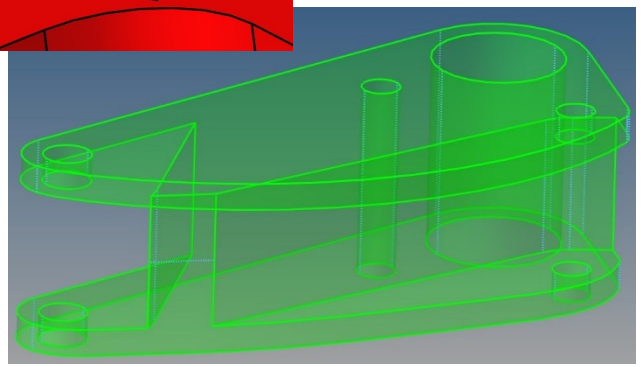
DESIGN SPACE E MESH





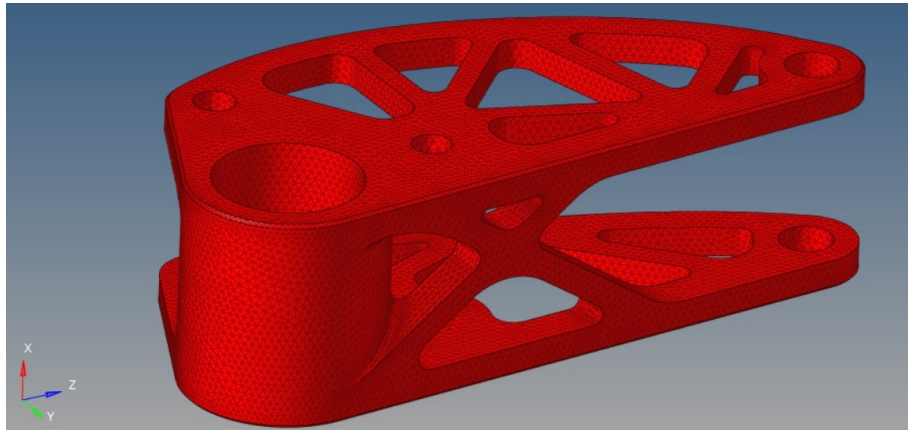
- Ingombri elementi cinematica

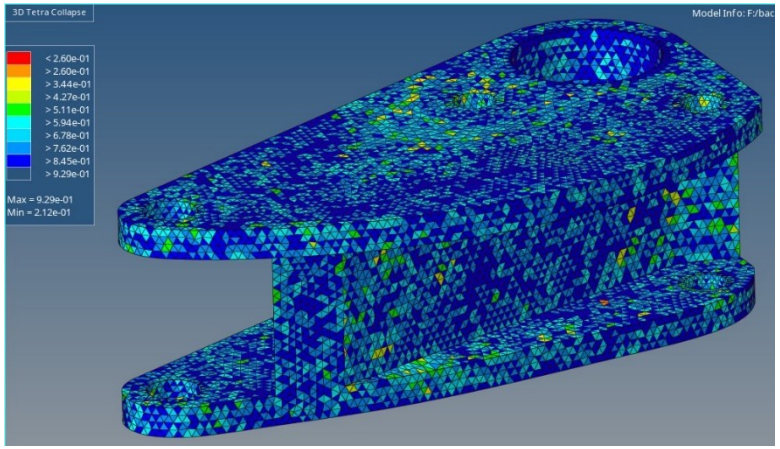




- Pulizia bordi superfici

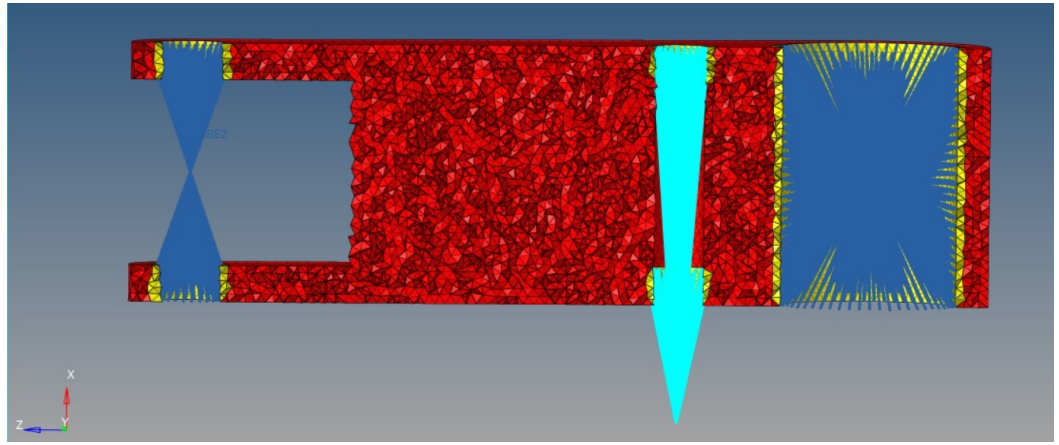
- Mesh tetraedrica



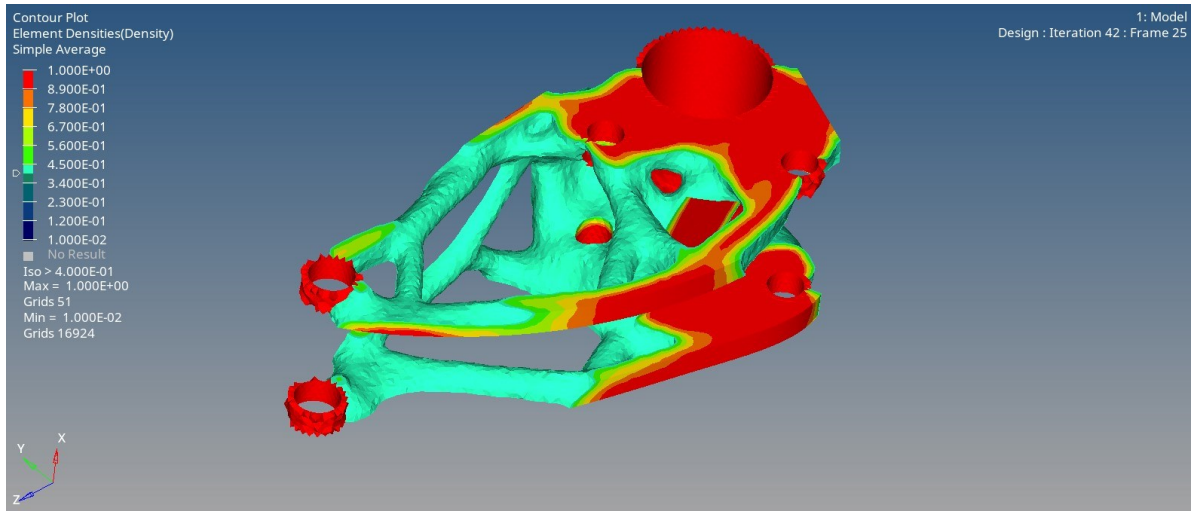


- Verifica della qualità degli elementi solidi

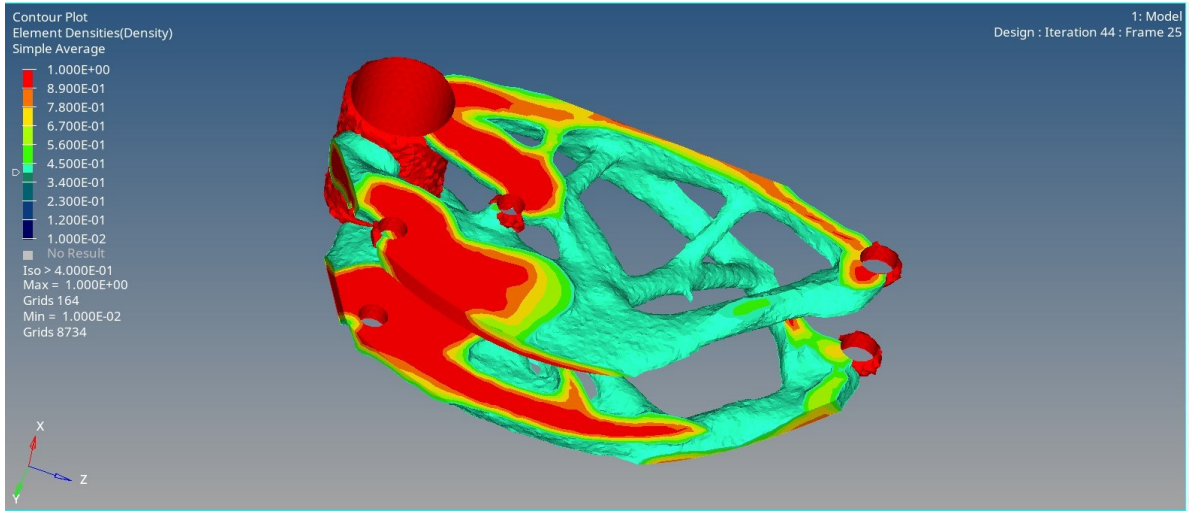
PARAMETRI DELL'OTTIMIZZAZIONE



- DESVAR
  - MIN DIM
  - STRESS CONSTRAINT
- RESPONSES
  - VOLFRAC
  - STATIC DISPLACEMENT
- OBJECTIVE
  - min VOLFRAC
- DCONSTRAINTS
  - max STATIC DISPLACEMENT

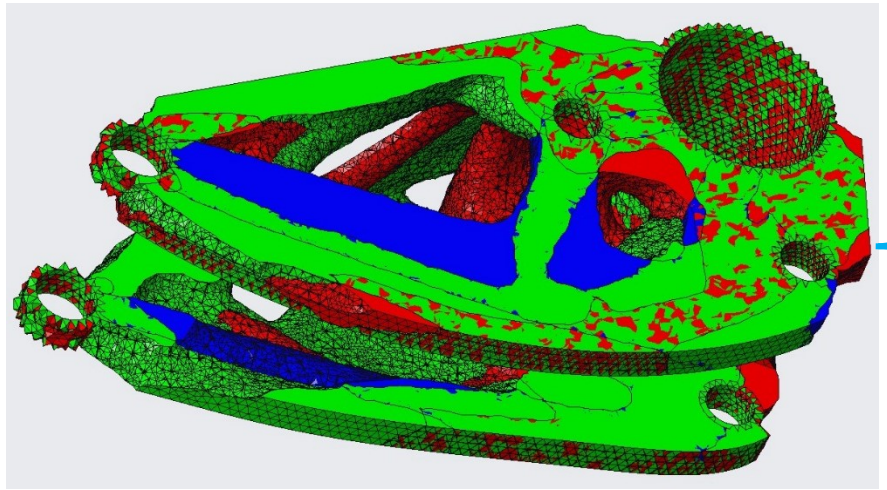


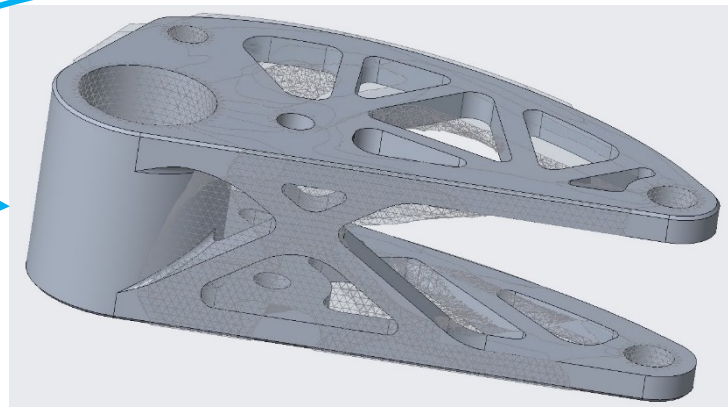
$Anteriore, caso\ t_{arb}$

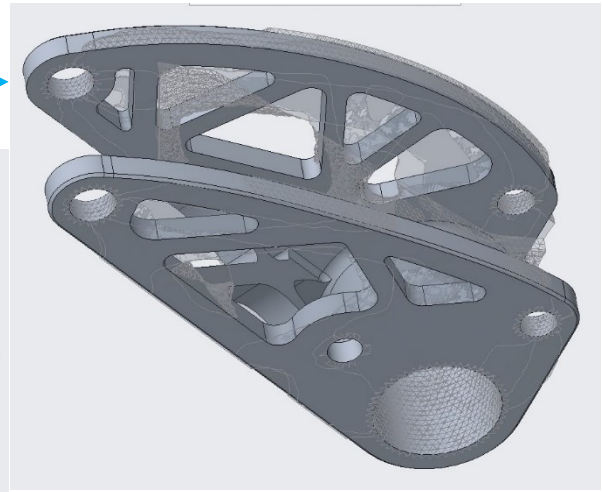


$Posteriore, caso\ t_{arb}$

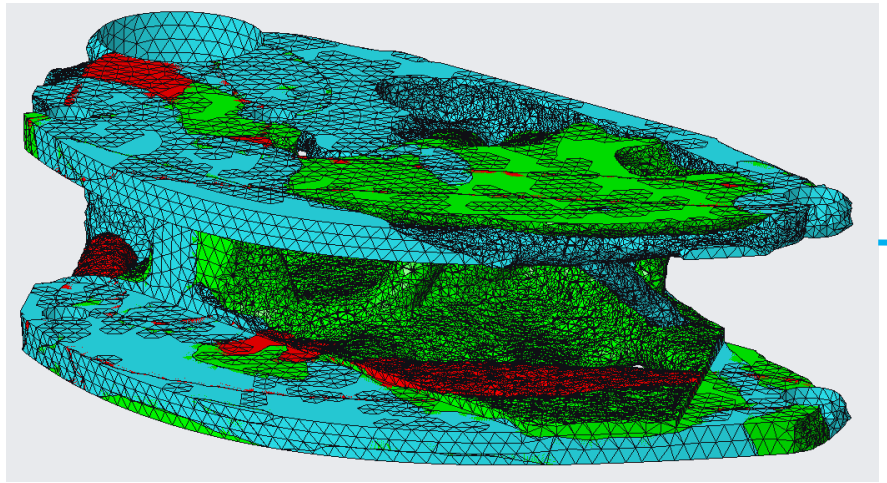
SOVRAPPOSIZIONE DELLE GEOMETRIE PROPOSTE DALL'OTTIMIZZAZIONE



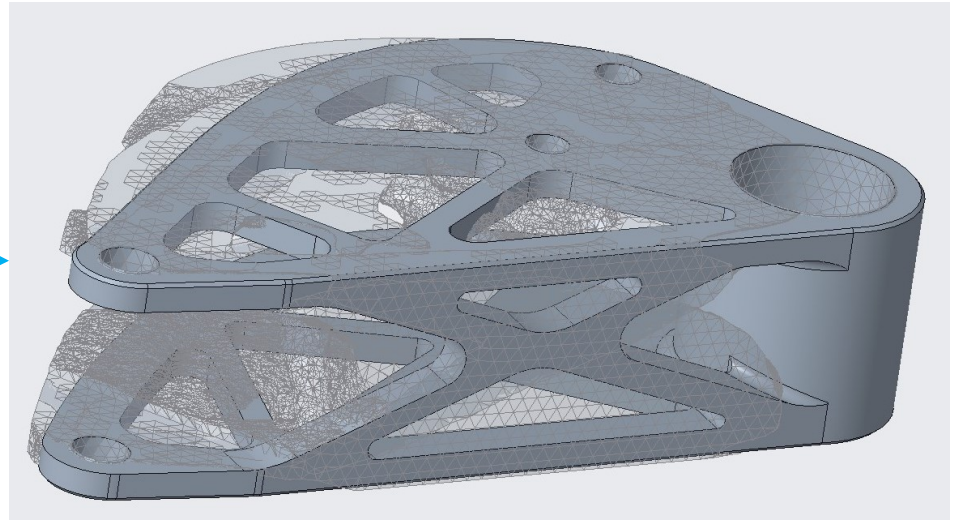




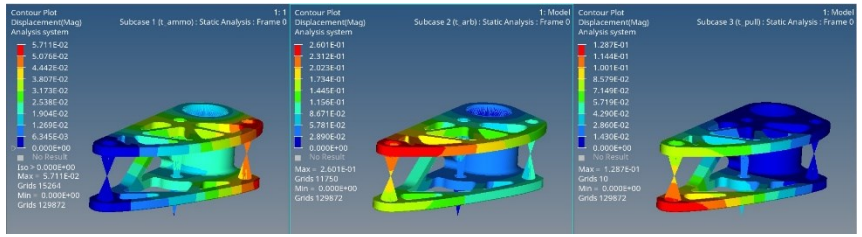
Anteriore



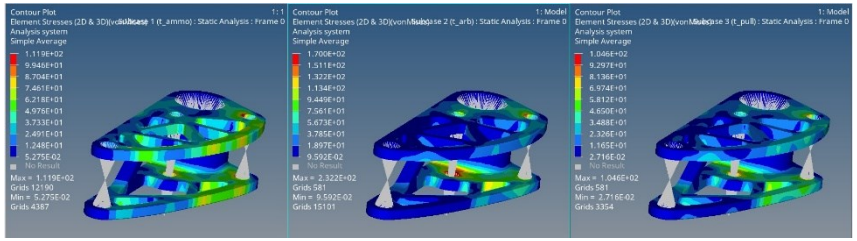
Posteriore



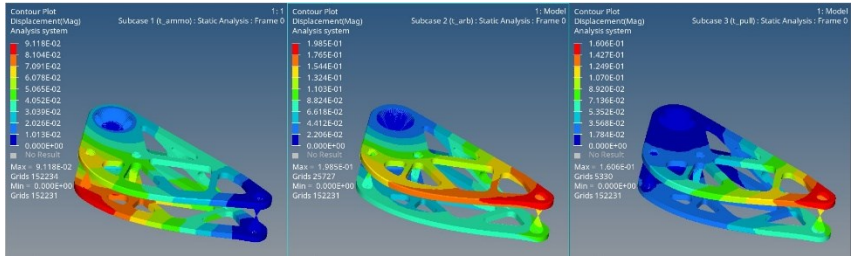
ANALISI FEM E RISULTATI



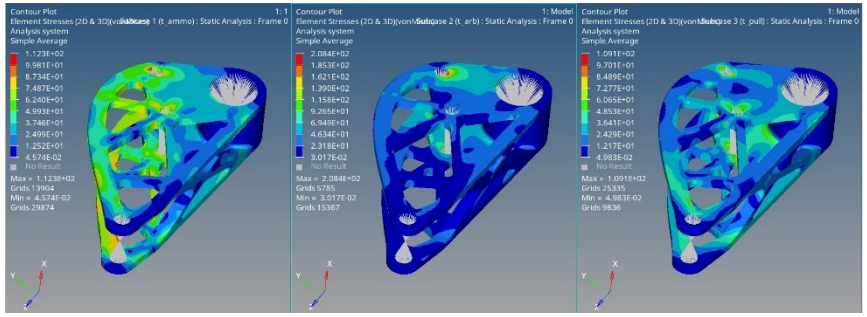
Anteriore, spostamenti



Anteriore, tensioni Von Mises



Posteriore, spostamenti



Posteriore, tensioni Von Mises

➢ COMPLIANCE

ANTERIORE			
	Vecchia geometria	Nuova geometria	ΔC[%]
t_{ammo}	162.53 [Nmm]	178.45 [Nmm]	+8.92%
t_{arb}	241.41 [Nmm]	257.06 [Nmm]	+6.09%
t_{pull}	99.74 [Nmm]	81.80 [Nmm]	-21.94%

POSTERIORE			
	Vecchia geometria	Nuova geometria	ΔC[%]
t_{ammo}	553.08 [Nmm]	341.21 [Nmm]	-38.31%
t_{arb}	248.88 [Nmm]	227.34 [Nmm]	-8.65%
t_{pull}	225.45 [Nmm]	126.34 [Nmm]	-43.96%

➢ STATIC DISPLACEMENT

	ANTERIORE			POSTERIORE		
	t_{ammo}	t_{arb}	t_{pull}	t_{ammo}	t_{arb}	t_{pull}
Δs_{ammo} [%]		-25.82%	-4.92%		+4.48%	-53.09%
Δs_{arb} [%]	-81.20%		-36.00%	-49.34%		-43.33%
Δs_{pull} [%]	+42.28%	-17.44%		-27.49%	+18.09%	

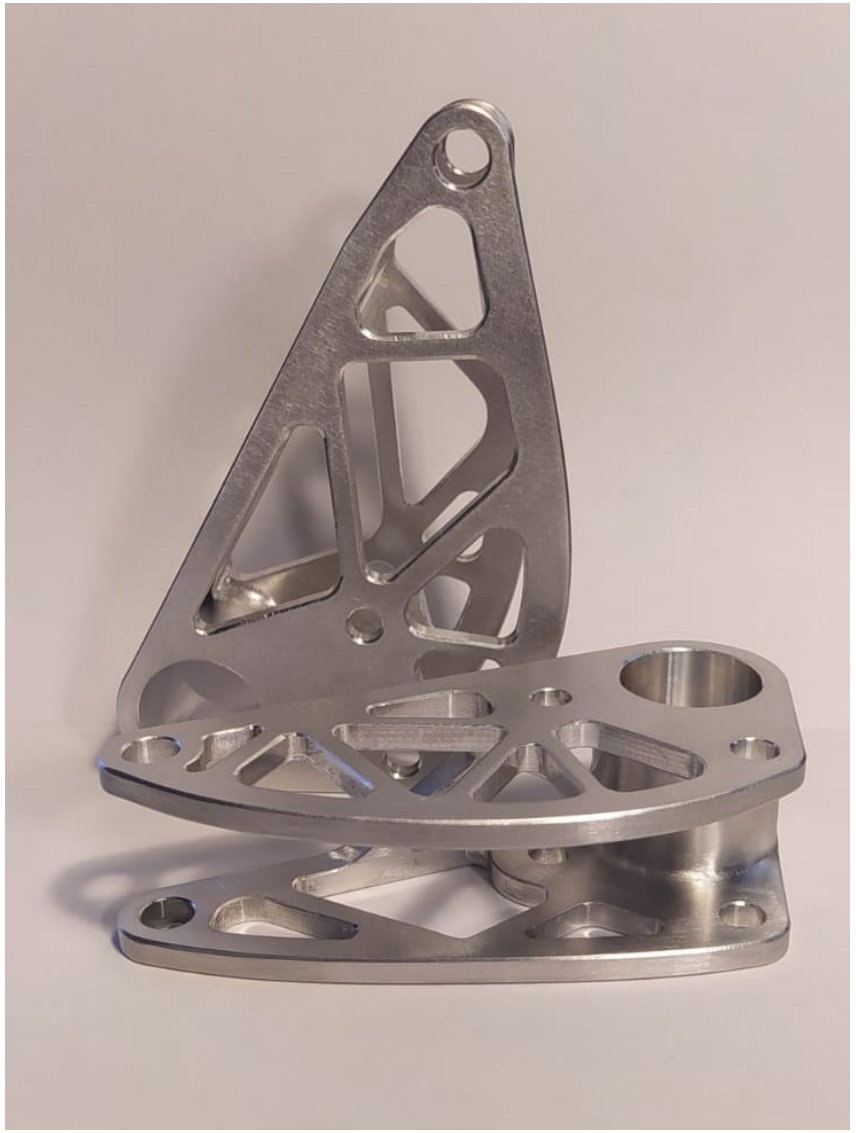
➢ COEFFICIENTI SICUREZZA CON CRITERIO VON MISES

ANTERIORE				
	σ_{vm} Vecchia geometria [MPa]	ν_S	σ_{vm} Nuova geometria [MPa]	ν_S
t_{ammo}	149.1	3.42	111.9	4.56
t_{arb}	235.0	2.17	232.2	2.20
t_{pull}	146.7	3.48	104.6	4.89

POSTERIORE				
	σ_{vm} Vecchia geometria [MPa]	ν_S	σ_{vm} Nuova geometria [MPa]	ν_S
t_{ammo}	221.2	2.31	112.3	4.54
t_{arb}	192.2	2.65	208.4	2.45
t_{pull}	171.2	2.98	109.1	4.67

➢ MASSA

	Vecchia geometria [g]	Nuova geometria [g]	$\Delta massa$[%]
ANTERIORE	74.39	86.03	+15.66 %
POSTERIORE	88.06	102.6	+16.52 %



OBIETTIVI FUTURI:

- Le F_{arb} e F_{pull} su piano (y, z) della squadretta.
- Additive manufacturing.