Metodi per la progettazione ed il monitoraggio di componenti strutturali in materiale composito per l'automotive.

Design methodologies and health monitoring systems of structural automotive parts made of composite materials.

Borsa di Ateneo XXXV Ciclo

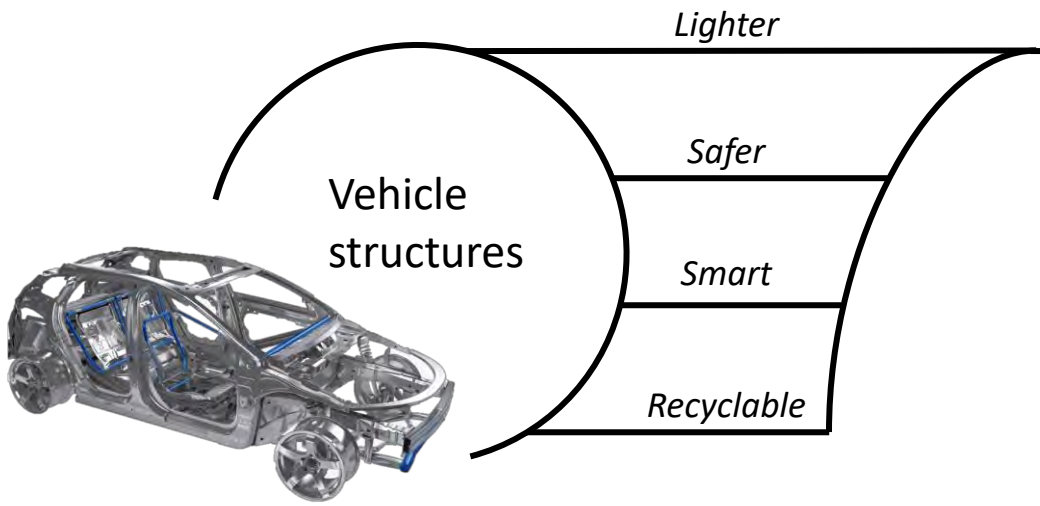
Candidato: ***A. Ciampaglia***

Dottorato in: ***Ingegneria Meccanica***

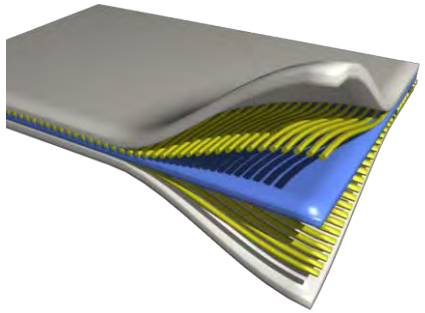
Tutore: ***Prof. G. Belingardi***

RESEARCH OVERVIEW

POLITECNICO DI TORINO
Dipartimento di Ingegneria Meccanica e Aerospaziale



Composite materials

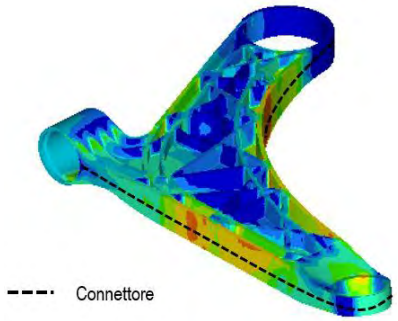


- ✓ Stiffness/density
- ✓ Strength/density
- ✓ Functionalization
- ✓ Tailored shape/characteristic
- × Post-impact damage
- × Costs
- × Mechanical complexity

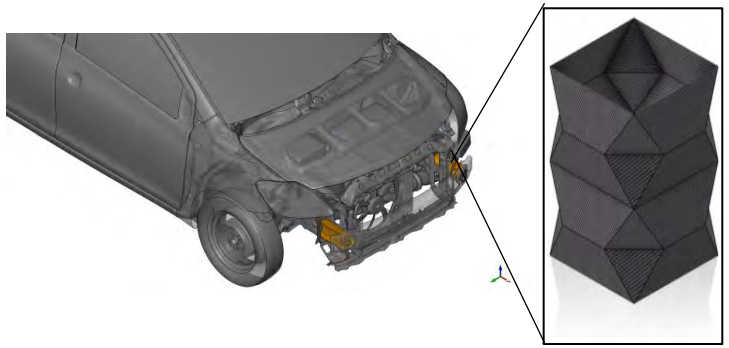
Research activity

Design of lightweight suspension

Structural Health Monitoring of Composite Suspension with AI method



Origami shaped carbon/epoxy crashbox



STRUCTURAL HEALTH MONITORING

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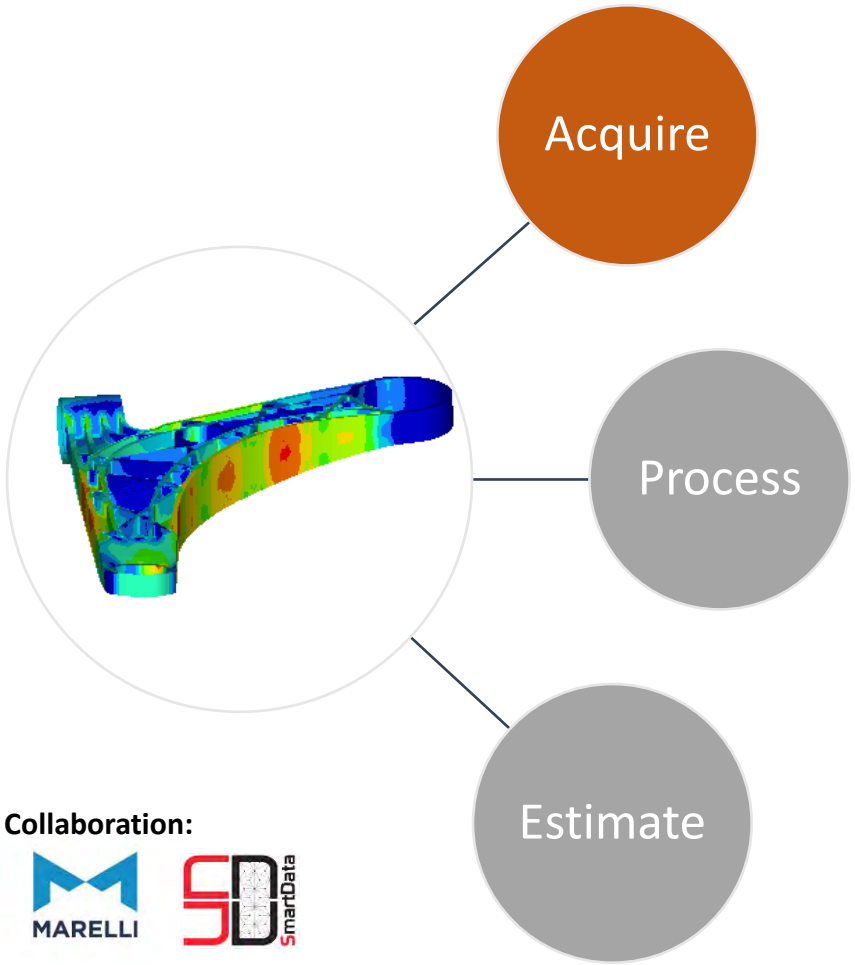
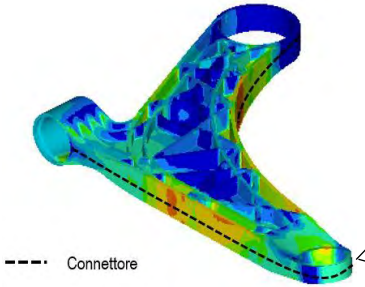
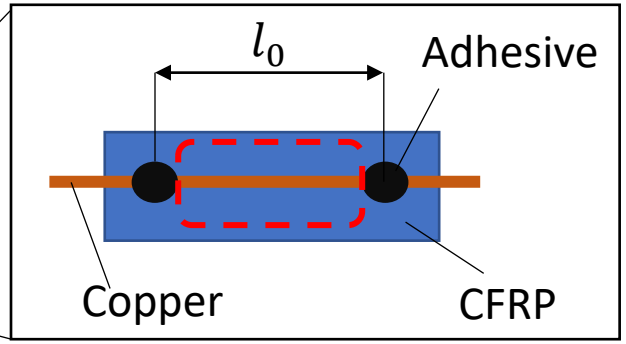


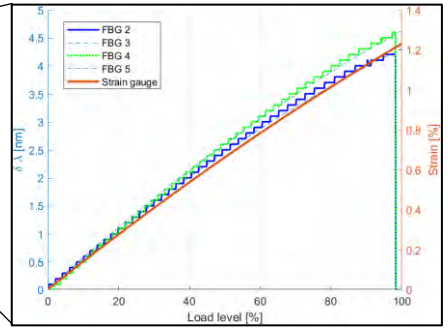
Conductive



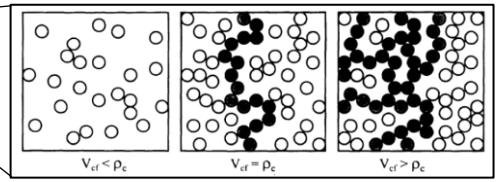


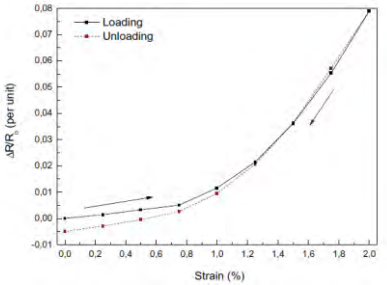
Optical

Embedded in laminates



Nano-particles





Collaboration:

MARELLI

SmartData

Addfor+

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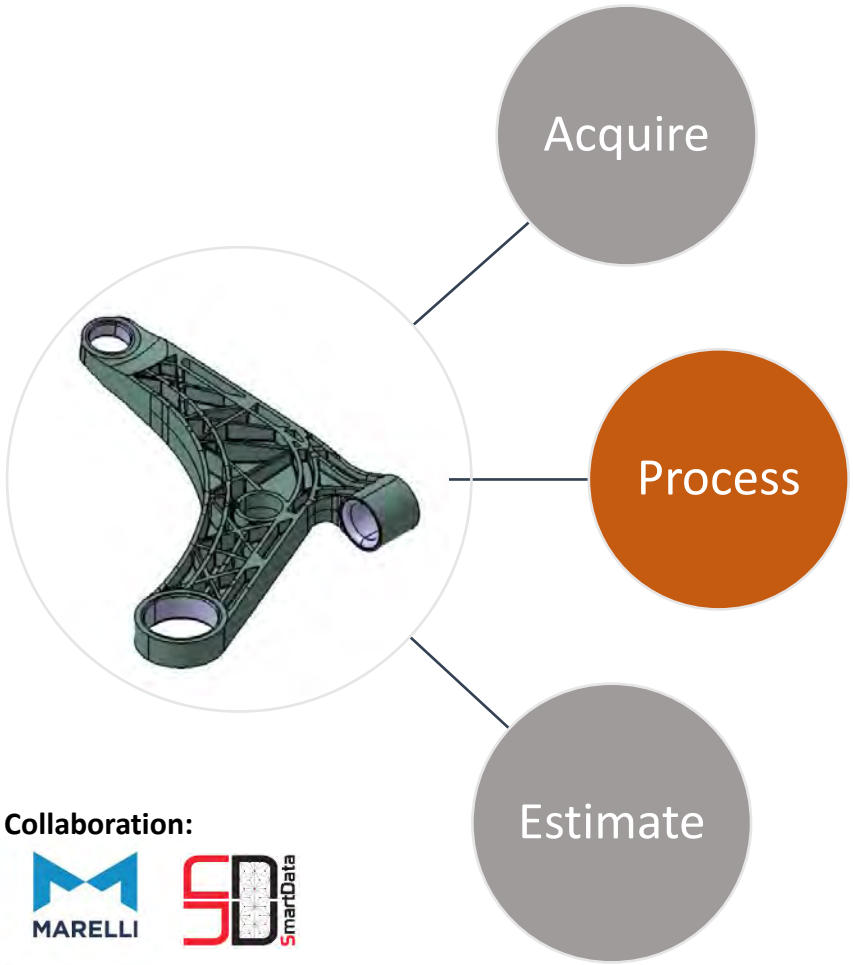
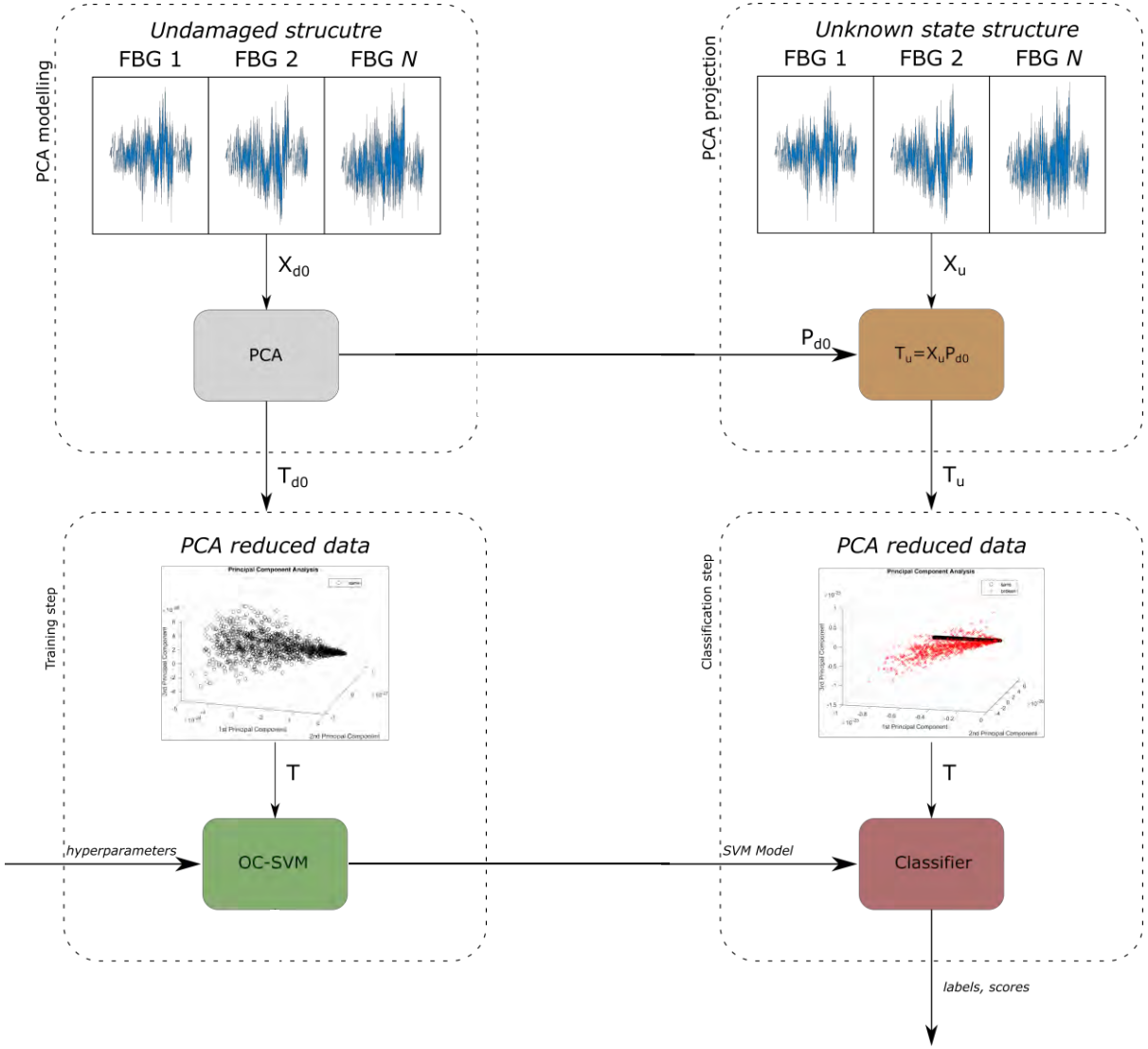


Collaboration:

MARELLI SmartData Addfor

Machine learning



STRUCTURAL HEALTH MONITORING

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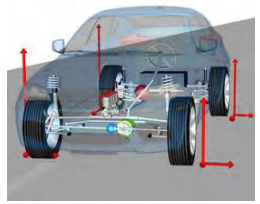
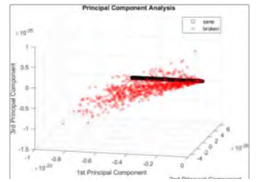
Virtual environment

CarSim Mechanical Simulation — **Vehicle dynamic**

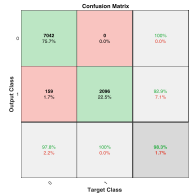


Altair — **FEM**

AI Algorithm

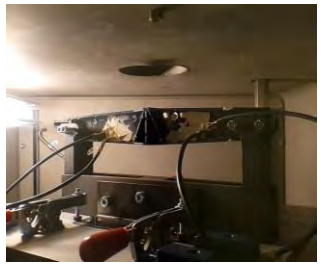


Damage index

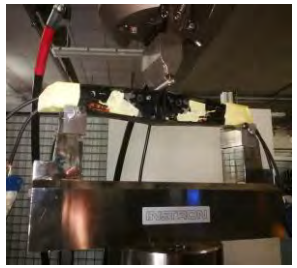


Experimental validation

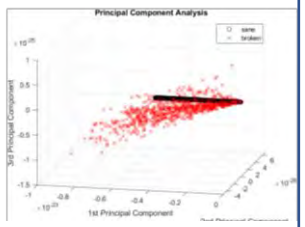
Drop damage



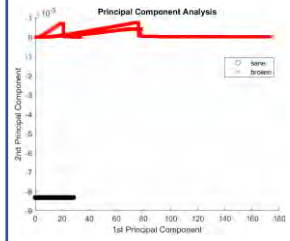
Quasi-static test



AI Algorithm



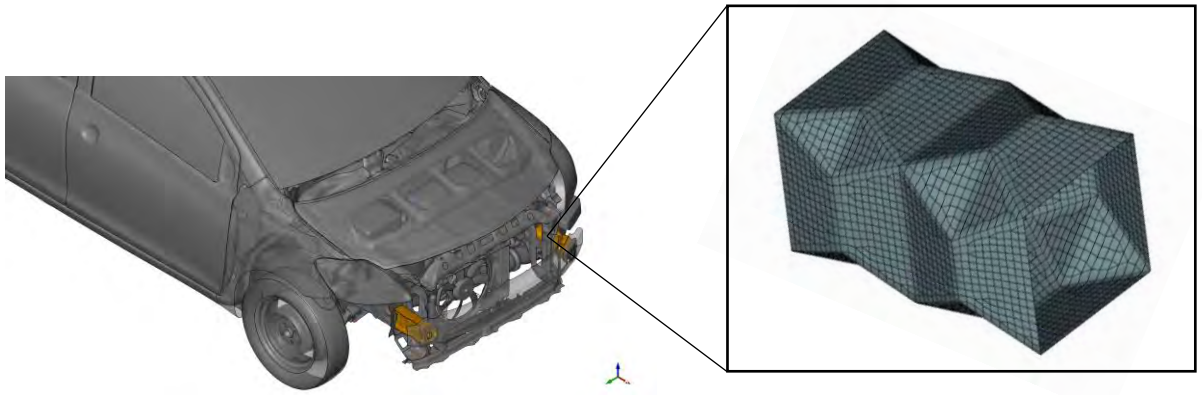
Damage index



Collaboration:

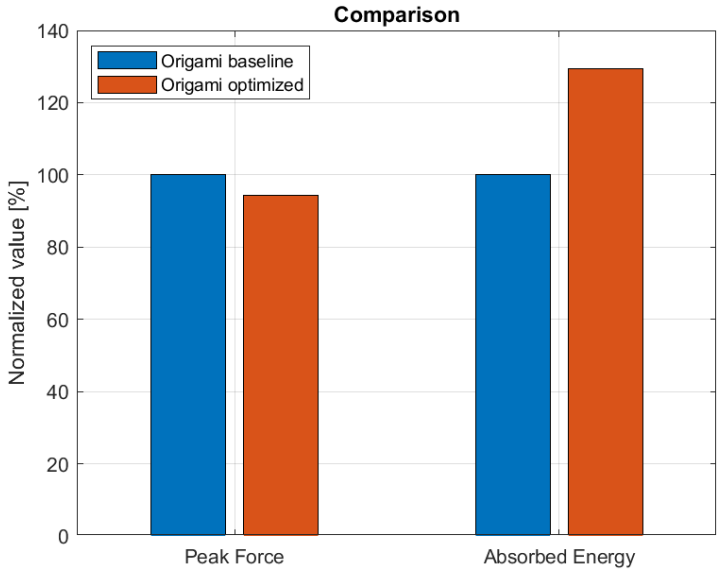
MARELLI — SmartData — Addfor+

ORIGAMI CRASH BOX



Absorb kinetic energy from impact
Preserve structural integrity of main subframe
Transmit low acceleration to the cockpit

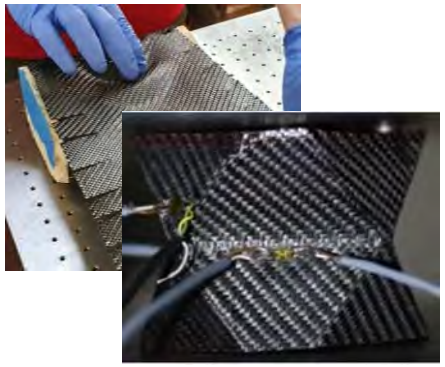
Achieved objective



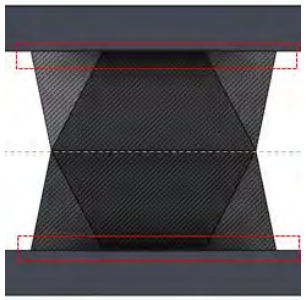
- ✓ Peak force 10% lower
- ✓ Absorbed energy 30% higher

Workflow

1. Prototype

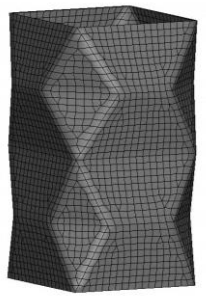


2. Test

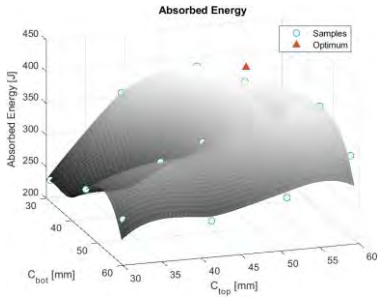


3. Morphing

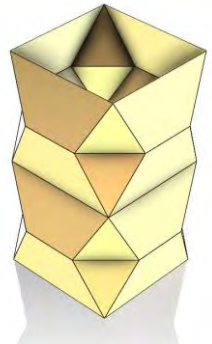
4. FEM



5. Optimize



6. Final design



FUTURE DEVELOPMENT

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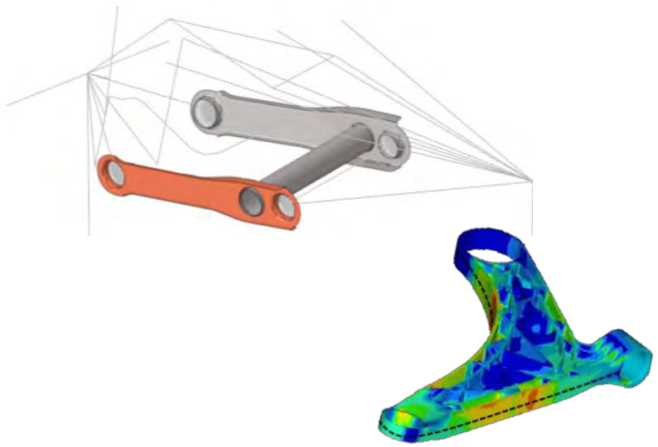
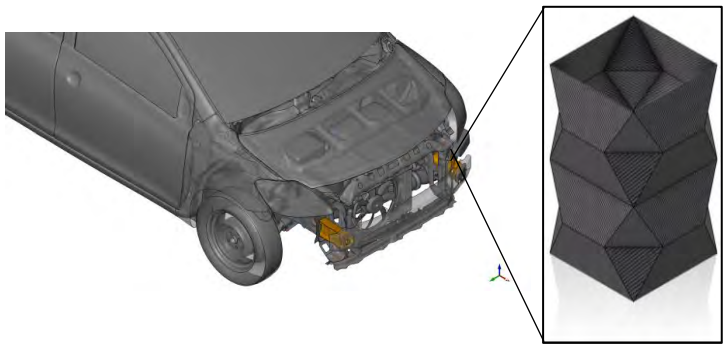
Design of lightweight suspension and monitoring system



- Prototype the composite suspension
- Perform experimental test on full assembly
- Deep study the fatigue/damaging behaviour of materials
- Integrate monitoring system on composite suspension
- Perform on-vehicle test
- Design a ECU deployable algorithm with high accuracy

Origami shaped carbon/epoxy crashbox



- Extensive experimental campaign with drop test on full size crash box
- Study the response of origami crash box to oblique impact
- Integration of origami crash box in full-vehicle FE models

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Dipartimento di Ingegneria Meccanica e Aerospaziale

Thank you for your kind attention!

Candidato: ***A. Ciampaglia***

Tutore: ***Prof. G. Belingardi***

Thanks to:

Publications and conferences:

[1] Ciampaglia A., Santini A., Belingardi G. 2020. Design and analysis of automotive lightweight suspension based on Finite Element Analysis. Proceedings Of The Institution Of Mechanical Engineers. Part C, Journal Of Mechanical Engineering Science, Online

[2] Ciampaglia A., Fiumarella D., Boursier C., Ciardiello R., Belingardi G. 2020. 'Impact simulation and shape optimization of an origami crash box made of carbon/epoxy composite material' . 23rd International Conference on Composite Structures & 7th international conference on Mechanics of Composite Materials. University of Porto, Portugal. 1-4 September.

[3] Ciampaglia A. , Belingardi G. 2019. 'Combined classification and regression artificial neural network for structural health monitoring in composite component of suspension.' . Automotive challenges in AI era. Politecnico di Torino, Italy. 31 October.