CIRI MECCANICA AVANZATA E MATERIALI

Redesign of structural metallic parts for additive manufacturing

Additive manufacturing technologies for metal materials offer numerous potential advantages, including: the ability to create complex shapes (impossbile to make by traditional processes); the integration of multiple functions into a single component; and the ability to fully exploit numerical shape optimization techniques. At the same time, applying these manufacturing technologies to industrial settings requires the development of appropriate design approaches and the acquisition of experimental data relevant to the mechanical performance of materials and products obtained through additive manufacturing (AM).

"Mechanical components: from traditional processes to additive manufacturing."

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Specialization Area	Mechatronics and Materials
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Keyword	Additive manufacturing, Redesign, Titanium alloys, Topology optimization

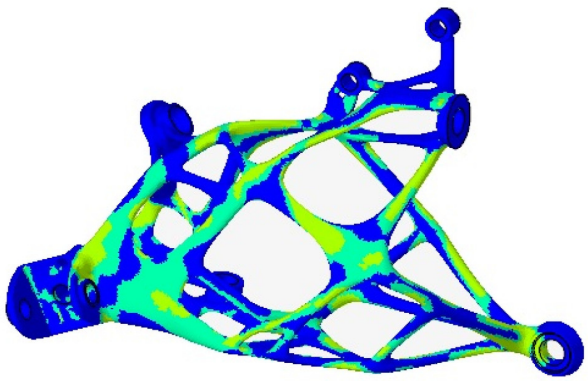


Fig. 1: Footpeg holder for a motorbike made by AM

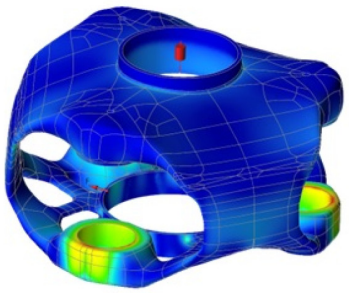




Fig. 2: FEA of a planetary gear carrier and SLM printed carrier

Description

Shape optimization techniques can benefit significantly from the use of AM. These processes theoretically allow for the creation of shapes that would otherwise be impossible to produce. However, the industrial use of 3D printing, particularly for metallic materials, requires detailed knowledge of numerous aspects, such as: the actual mechanical properties of the printed parts; any necessary post-treatments; and the design adjustments needed to overcome technological limitations. The expertise developed by CIRI MAM in these areas, including that accumulated during the AMMT project, enables the provision of highly specialized services to companies wishing to redesign (or design from scratch) machine components and assemblies for additive manufacturing.

Innovative aspects

CIRI MAM, also through the expertise developed in the AMMT project, encompasses all the skills and instrumental resources necessary to implement the transition from traditional production processes to additive manufacturing: from mechanical characterization of specimens or components, to metallographic analyses, to redesign using shape optimization techniques, to the definition of appropriate heat and/or surface treatments.

Potential applications

The potential applications of the methods and processes developed in the AMMT project could involve structural mechanical components in multiple industrial sectors, such as automotive, power transmission, earthmoving, aerospace, and defense.



Fig. 3: AM titanium footpeg holder for a sports motorbike.

Application example

Redesign of two structural components for additive manufacturing.

AM design methods and related manufacturing processes were tested in an industrially relevant context on two case studies: a high-performance motorcycle footpeg holder (provided by Ducati Motor Holding Spa) and a planetary gear carrier for planetary gearboxes (Bonfiglioli Riduttori Spa). In both cases, topological optimization techniques were used to tailor the final model's shape. The reconstruction took into account the constraints introduced by the manufacturing process (e.g., redefinition of excessively slender elements, inclusion of support areas, reduction of unsupported elements) as well as aesthetic requirements, where applicable. In the case of the footpeg holder, the original component, machined out of an aluminium alloy, was replaced by a titanium alloy component manufactured using a powder bed fusion process: the finished component weighs approximately 20% less than the original component. For the planetary carrier case study, we switched from a cast iron component to a stainless steel component, manufactured using a powder bed fusion process, resulting in a weight saving of approximately 30%.

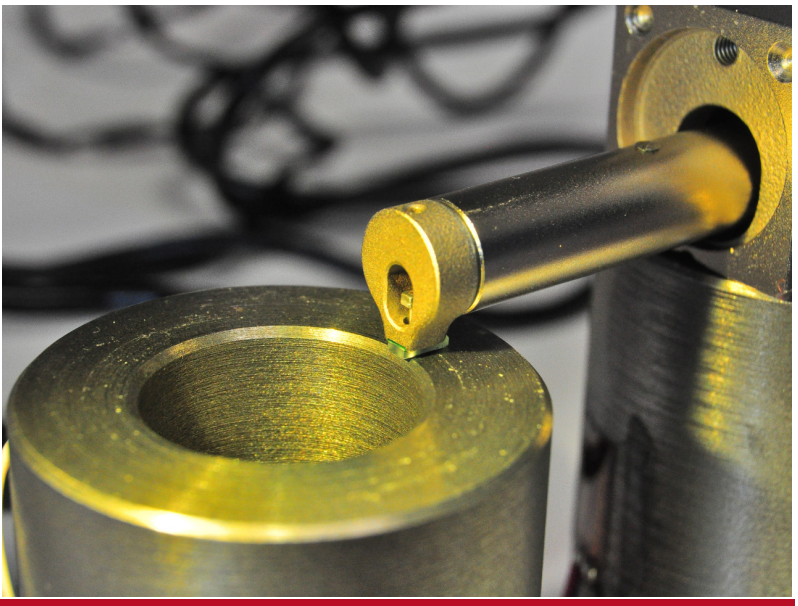
Involved partners	BI-REX, Poggipolini Spa, Bonfiglioli Riduttori Spa, Ducati Motor Holding Spa, Altair Engineering Srl, Juno Design Srl, Guidetti Technology Srl.
Implementation Time	24 months
Technology Readiness Level	TRL7 - System prototype demonstration in operational environment
Exploitation	Looking for business partners for further applications.

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CIRI MAM

Centro Interdipartimentale di Ricerca Industriale Meccanica Avanzata e Materiali

Il CIRI-MAM è il Centro Interdipartimentale per la Ricerca Industriale dell'Università di Bologna che opera nei settori della Meccanica Avanzata e dei Materiali. E' una struttura creata dall'Università di Bologna nell'ambito del progetto Tecnopoli, sviluppato dalla Regione Emilia Romagna, Programma Operativo Regionale del Fondo Europeo di Sviluppo Regionale.
Il CIRI-MAM è organizzato su sei unità operative (UO), ognuna caratterizzata da specifiche competenze e dotazioni strumentali: (i) Automazione, robotica e meccatronica, (ii) Materiali avanzati e applicazioni per la nautica, (iii) Materiali avanzati per la progettazione e applicazioni fotoniche, (iv) Materiali strutturati e/o compositi per applicazioni avanzate, (v) Prototipazione virtuale e modellazione sperimentale di sistemi meccanici, (vi) Chimica e tossicologia dei materiali.



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Published on 23/02/2026