



PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 39th cycle

**THEMATIC Research Field: SUSTAINABLE REMANUFACTURING OF AUTOMOTIVE
COMPONENTS**

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

**Motivation and objectives of the research
in this field**

Remanufacturing is the most valuable circular economy option, providing relevant economic returns to European manufacturing companies, contributing to the creation of knowledge-intensive jobs and new skills. Remanufacturing also reduces the dependency on the extraction and supply of critical raw materials in Europe, evidenced by the environmental benefits in terms of material consumption (-80% on average) and CO₂ emissions (-90%) with respect to new manufacturing operations. Remanufacturing is a standardized industrial process by which post-use products are returned to same-as-new, or better, condition and performance. The process is in line with specific technical specifications, including engineering, quality and testing standards. The process yields fully warranted products. A remanufactured part fulfills a function which is at least equivalent compared to the original part. Differently from manufacturing operations, in remanufacturing product variations and uncertainties are generated within the use-phase and observed by the system in the input flow of post-consumer products. The main objective of the remanufacturing process is to smooth the propagation of the product variability throughout the remanufacturing value-chain and factory stages. The quality requirements from the recovered parts are extremely demanding, since "as good as new" critical product characteristics have to be guaranteed. The regeneration rate in remanufacturing is usually between 50%-70%. The objective of the



	research activity is the development of novel zero-defect manufacturing approaches and methods to increase regeneration rates in remanufacturing, with focus on emerging e-mobility components to support the ongoing transformation of the automotive industry.
Methods and techniques that will be developed and used to carry out the research	The PhD work will be focused on the following phases: •Critical analysis of e-vehicle components and identification of the most promising components for future remanufacturing operations; •Reverse engineering and reverse Bill-of-Material techniques for identifying re-usable, regenerable and substitutable sub-components for remanufacturing the product for function restore; •Analysis of the potential failure modes of post-use products returning from the use-phase and statistical analysis of occurrences; •Identification and development of suitable inspection techniques for post-use product characterization, exploiting Artificial Intelligence and the Digital Product Passport - DPP data; •Development and testing of in-process zero-defect manufacturing techniques for variation propagation smoothing and function-oriented assembly aiming at increasing regeneration rates in remanufacturing; •Validation of the entire approach on a sub-set of sample products returning from the use phase. •Design of novel circular economy business cases, exploiting the developed technological solutions.
Educational objectives	Enhance competences on sustainable manufacturing, twin-transition, circular economy business cases focused on remanufacturing and contributing to a sustainable energy transition of the automotive industry.
Job opportunities	Our last survey on MeccPhD Doctorates highlighted a 100% employment rate within the first year and a 35% higher salary, compared to Master of Science holders in



	the same field. The research activity will be carried out in cooperation with APRA - Automotive Part Remanufacturing Association.
Composition of the research group	2 Full Professors 3 Associated Professors 3 Assistant Professors 4 PhD Students
Name of the research directors	Prof. Marcello Colledani

Contacts
For questions about scholarship/support, please contact phd-dmec@polimi.it .

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops and conferences) for a total amount of euro 5.707,13. Our candidates are strongly encouraged to spend a research period abroad, joining high-level research groups in the specific PhD research topic, selected in agreement with the Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approx. 700 euro/month - net amount). Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.