Empower students to achieve their goals through the highest quality education and research

Advance research and innovation technologies to tackle society challenges

Contribute to the strategic goals of La Sapienza University as a prominent player for research and education in the national and international context

Build a multi-disciplinary network sharing ideas and knowledge to look at excellence and innovation

Promote and develop the major areas of scientific knowledge and competencies to foster international collaborations and partnerships along major strategic research lines

Support our greatest asset: Students, Faculty and Staff to improve community cooperation
Innovation and frontier research in Mechanical and Aerospace engineering requires key enabling capabilities, a result of an integrated and multidisciplinary vision.

"Horizontal" lines
Enabling technologies

- Mathematical modeling and numerical simulation
- Experimental research
- Design and construction
- Complex Systems
- Bioengineering and human-machine interface

“Vertical” lines
Multidisciplinary Competence Centers

- AERO SPACE SYSTEMS
- HPC (high performance computing)
- INTEGRATED ENGINEERING (Industria 4.0)
DIMA intends to develop an integrated vision of **education, research and innovation** through the establishment of **Competence Centers** on specific strategic lines.

**Competence Centers:**

- are open spaces with the role of scientific and technological hubs
- coordinate DIMA research groups
- operate in multidisciplinary and cross-disciplinary way on scientific lines of DIMA
- develop business relationships through specific "labs for design"

In **Competence Centers**, researchers and students can share design lines collaborating with other universities, institutional agencies, research centers and companies.
1. AEROSPACE SYSTEMS - SMALL SAT, SPACE SCIENCE AND ACCESS TO SPACE
Conception and design of satellite constellations, of small SAT platforms and of the enabling technologies. Space access: development and evolution of small launchers (VEGA) and related technologies. Solar System exploration and development of space science on small satellites. New aeronautical systems, remotely piloted systems, suborbital flights.

2. COMPUTATIONAL MECHANICS - HIGH PERFORMANCE COMPUTING
Development of algorithmic capabilities on advanced computing systems (Exascale Supercomputers, hybrid GPU/CPU clusters) according to the European road map for Exascale Computing. Multiscale and multiphysics analysis for the design of complex systems for future engineering applications.

3. INTEGRATED ENGINEERING: DIGITAL MODELLING AND ADDITIVE MANUFACTURING
Establishment of integrated engineering approaches (INDUSTRIA 4.0), for the development of products in a long-life cycle perspective, by combining methodologies of Inventive and Innovative Design with Digital Design and Additive Manufacturing technologies.
The future of the space field foresees the development of systems capable of undertaking complex scientific and practical missions. The policies of the major Space Agencies (e.g. ESA's Space 4.0), the initiatives promoted for the development of mega-constellations in the US, and the Space Economy define the development trends:

- Design of innovative Space Systems, to satisfy final user demands, reducing manufacturing costs.
- Promote the development of the Space Economy, a value chain generating products and innovative services, “Downstream”, from research, development and enabling space infrastructures “Upstream”
Exascale Supercomputers available in the next future (1 exaflop = 10^18 flops)

HPC enabling technology to design future complex systems

The aim is to develop models for new complex, multiscales and multiphysics mechanical systems, according to the new paradigm Mathematical Model, Algorithm, Implementation, Simulation

Courtesy of CINECA

From ECP
INDUSTRIA 4.0: a change in the manufacturing and logistic paradigm

Development of analysis and design capabilities for the future Engineering challenges (IoT, digital factory, machine learning, cobotics, virtual prototyping, additive manufacturing)
### DIMA OVERVIEW

<table>
<thead>
<tr>
<th>Category</th>
<th>Summary</th>
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<tr>
<td><strong>58</strong> Faculty Members</td>
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<tr>
<td><strong>30</strong> Research Associate</td>
<td></td>
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<tr>
<td><strong>21</strong> Staff</td>
<td></td>
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<tr>
<td><strong>3000+</strong> Students</td>
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<tr>
<td><strong>1</strong> Main Site</td>
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<td><strong>2</strong> Complementary Sites</td>
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<td><strong>24</strong> Labs</td>
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<tr>
<td><strong>2</strong> Bachelor Degrees</td>
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<td><strong>3</strong> Master Degrees</td>
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<td><strong>3</strong> PhD Programs</td>
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<td><strong>5</strong> Professional Master PhD Programs</td>
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*Dipartimento di Ingegneria Meccanica e Aerospaziale*
OBJECTIVES

- Education
- Research
- Third Mission
EDUCATION
ACADEMIC PARTNERSHIPS
BACHELOR AND MASTER OF SCIENCE

DIMA offers two Bachelor of Science and three Master of Science courses lasting three and two years respectively. Undergraduate application requires an admission test.

Bachelor of Science
- Aerospace Engineering
- Mechanical Engineering

Master of Science
- Aeronautical Engineering
- Space and Astronautical Engineering
- Mechanical Engineering
Ph.D.

PhD programs aim at training the skills needed to carry out high quality research activities in the aerospace, industrial and mechanic field.

- Aeronautics and Space Engineering
- Theoretical and Applied Mechanics
- Industrial and Management Engineering

Professional Master Programs

These post-graduated programs last one year and admission requires a MSc degree.

- Satellite Systems and Services
- Space Transportation Systems
- Civil Aviation Management
- Energy Efficiency and Renewable Energy Sources
- Inventive Engineering
RESEARCH
FUNDING AND GOVERNMENTAL AGENCIES
Space Science  
Computational Mechanics  
Energy and turbomachinery  
Space Propulsion  
Aerospace Technologies  
Advanced Composite structures  
Additive Manufacturing  
Automotive  
Engineering for Cultural Heritage  
Advanced Design & Production Processes  
Engineering for Health

- Participation in deep space missions: Cassini (Saturn) - Juno (Jupiter) - BepiColombo (Mercury)
- Tests of relativistic gravity
- Determination of planetary mass distribution
- Space Surveillance and tracking
- Development of satellites systems

- Numerical simulations of nanoscale wetting and cavitation
- Cavitation at the mesoscale and multiphase flow physics
- Transport of bubbles and particles in turbulent flows
- Large scale DNS of high-Reynolds-number turbulent flows
- Supercritical Combustion in LRE Chambers
ENERGY AND TURBOMACHINERY

- Internal and film cooling in gas turbine blades
- Analysis of impact deposit and erosion in turbomachines
- Design of innovative fans and compressors
- Large unstructured data sets analysis and optimization
- Simulation and optimization of energy systems and micro grids
- Fuel cells and storage
- Biomasses and biofuels

DMFC7. Test rig for a 1.5 kW Direct Methanol Fuel Cell system for 800 h of permanent degradation test.

Wells Turbines for open sea applications

Vegetable oils fuelled common-rail engine installed at DIMA Lab
Additive manufacturing
• Foam fabrication and powder characterization
• Laser processes of materials
• Advanced testing of materials
• Digital image correlation (DIC) measurements
• Design and topological optimization
• Virtual prototyping and process design
• Tactile perception experiments
Composite material component with embedded self-powered wireless sensor device for structural monitoring
Patent RM2013A000584
P. Gaudenzi L. Lampani

- Wireless smart composite structures
- Damage detection on sensorized composite structures
- Composite structures manufacturing lab
- Nonlinear aeroelastic modeling for flexible airfoils

- Robust IP protection
- Vibration and acoustics prediction
- Smart suspension and tyre control
- Damping Control and Energy Harvesting
- Signal analysis on board
- Structural design of vehicle and its parts
- Analysis of aerodynamics and materials
- Vehicle dynamics
- Composite structure testing for racing car design
- Innovative drivetrain devising for racing car design
• Analysis of liquid and solid rocket engine performance
• Space launchers vibroacoustics (Vega)
• Wall heat flux estimation in thrust chambers
• Multibody dynamics for space applications
• Transonic nozzles and shock/turbulence interaction
• Numerical Simulations of Hybrid Rockets
• Nozzle design and operations
• Wall heat flux estimation in thrust chambers
• Combustion study with different approaches (Turbulent combustion closure - ignition transient in CC - supercritical combustion in LRE chambers...)
Facility for flight simulations (Flight Dynamics Lab)

- Small vehicle design and FCS developments
- Flight dynamics of flexible aircraft
- Aeroelastic modelling
- Blade vortex interaction noise control
- FE model structural updating
Industrial Mechanical Systems Eng.

- Rating model for Health and Safety
- Spare parts management for complex systems
- Quality monitoring for airport ground handlers
- Industry 4.0
- Resilience Engineering for complex systems
- Supply Chain rating model
CULTURAL HERITAGE

“La resurrezione di Lazzaro”
Caravaggio

“Il principe ellenistico”

“Il Cartone per la scuola di Atene”
Raffaello

• Experimental-numerical techniques applied to the restoration of cultural heritage
  • Phase-shift measurement technique
  • White light speckle DIC
  • Reverse engineering + FE analysis
Characterization of mouse tibia mechanical properties through the Digital Image Correlation System

- Measurements for tissue engineering
- Motion Analysis
- Robot Mediated Therapy
- Medical Imaging
- Wearable monitoring systems for medical and sport applications
Spin-off Companies promoted by DIMA members

THIRD MISSION
INDUSTRIAL PARTNERSHIPS