UC3M R&D
in the area of health and healthcare technologies

IDENTIFICATION OF RESEARCH ACTIVITY, TECHNOLOGIES, PATENTS, INFRASTRUCTURES AND OTHER UC3M CAPABILITIES IN THE AREA OF HEALTH AND HEALTHCARE TECHNOLOGIES

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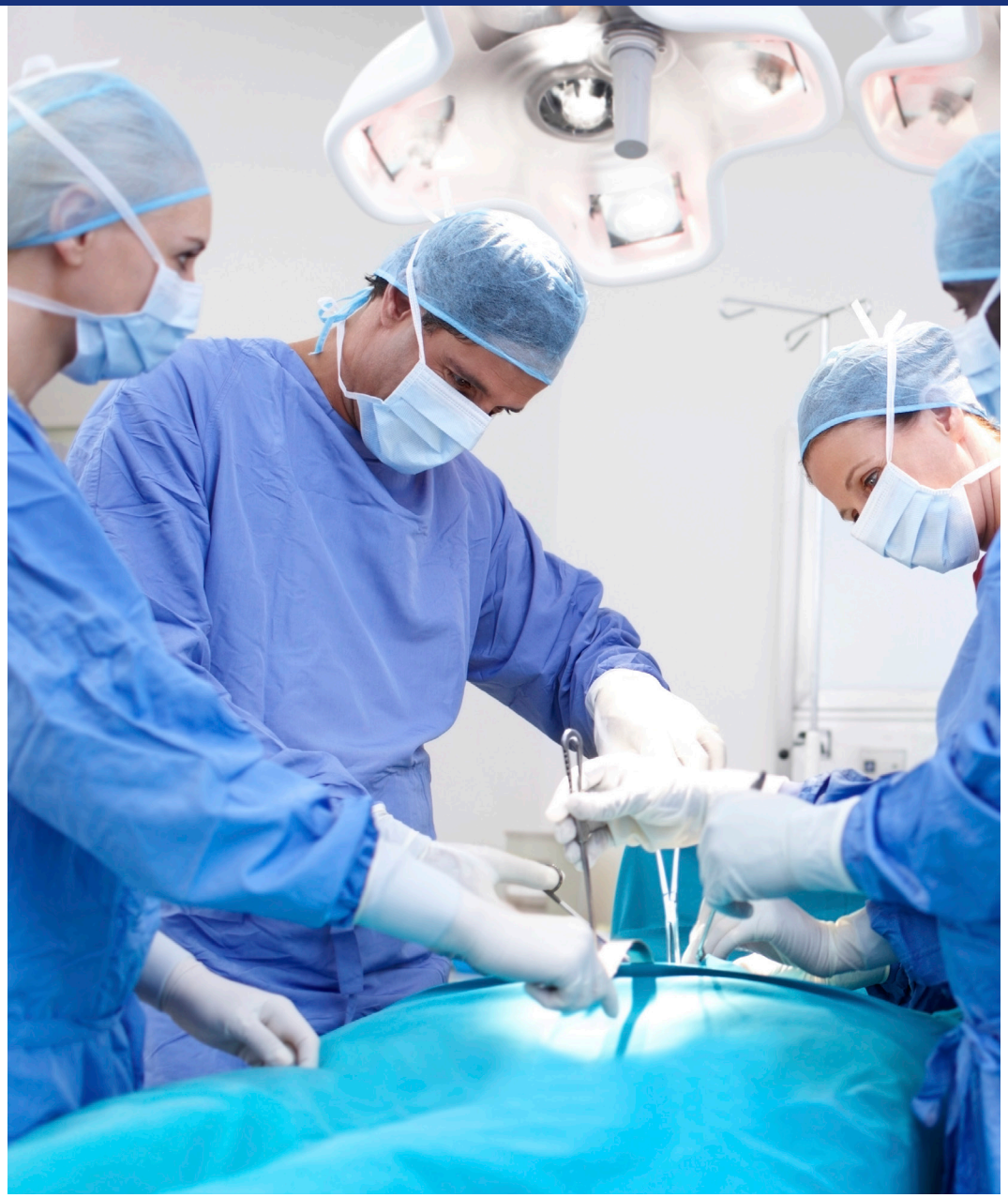
TECHNOLOGY ROADMAP UC3M – AREA OF HEALTH AND HEALTHCARE TECHNOLOGIES



The Entrepreneurship and Innovation Service SEI-Science Park of the Universidad Carlos III de Madrid wants to present the potential of the university in this "knowledge map" through the research areas developed in the frame of R&D projects, both national and international, patents and other results of UC3M investigators, in the Health Area.

The global knowledge obtained, the experience of collaborating with the industry, the existence of infrastructures and proper laboratories and, above all, the multidisciplinary nature of UC3M are characteristics that provide an added value so that our support towards the innovation of institutions, big companies and SMEs has an integral quality.

We invite you to deepen the knowledge of the UC3M and to collaborate in new R&D and innovation projects.

Entrepreneurship and Innovation Service-Science Park
Universidad Carlos III de Madrid

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R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - BIOENGINEERING AND AEROSPACE ENGINEERING

Biomedical Imaging and Instrumentation Group (BiiG)

PI: Manuel Desco Menéndez

- Technological development of high resolution imaging in laboratory animals: PET, SPECT, high resolution x-ray (CT) and optical tomography systems, and multimodal PET/CT, SPECT/CT, or FMT/CT systems.
- Biomedical cardiac imaging: quantification of functional biomedical images (tissue Doppler echocardiography, cardiac magnetic resonance and cardiac CT imaging methods, cardiac contractile function analysis, etc.
- Magnetic resonance imaging: development of new acquisition sequences, hardware components (antennas) and biomedical and clinical validation of the results, primarily in cardiology and neuroimaging; study of the biological effect of MRI electromagnetic fields, post-processing of functional MRI (fMRI), MR spectroscopy, and new reconstruction techniques.
- Neuroimaging: study of brain volume changes in adolescent patients, early diagnosis in Alzheimer's, study of the regions of the brain involved in mathematical reasoning. Furthermore, various multimodal quantification software tools have been developed.
- Multimodal imaging: development of tools for analysing MRI, CT and nuclear images.

European Projects

- CONEX: MN-MRI/PET- Development of a Hybrid Multinuclear-MRI/PET System for Preclinical Imaging.
- HFSP-An innovative, interdisciplinary model system for studying the developmental origins of sleep and brain rhythms.
- High Throughput Optical Tomography.
- INFIERI: Intelligent Fast Interconnected and Efficient devices for Frontier Exploitation in Research and Industry.
- PreDict-TB: Model-based preclinical development of anti-tuberculosis drug combinations.
- SUpeR REsolution Adaptive LIght Sheet Microscopy for high resolution volumetric imaging in turbid specimen (SURE-ALISM).
- TAHITI: Improving therapy and intervention through imaging.

R&D National Plan Projects

- Breakthroughs in radiological imaging.
- Image-based characterisation of the mechanics of tumour cells.
- Decrypting the structure and function of cellular protrusions in three-dimensional migration.
- DoI-ToF detector for PET compatible with MRI.
- High throughput 3D optical imaging with phase information for *in vivo* microscopy.

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Experience and Capabilities

- The work of the BiiG group essentially focuses on research on medical imaging techniques both in relation to the development of new technologies and advanced reconstruction and processing methods and to their practical application in the areas of x-ray tomography and nuclear, magnetic resonance and optical tomography imaging. The markedly multidisciplinary character of the group facilitates a strong connection with real clinical and preclinical needs.

Patents

- Scintillation cell (P201631258).
- Multiple-loading device for a flat laser beam microscope (ES2607633, WO2017055673).
- Device for holding samples for a microscope (P201630364, PCT/ES2017/070184).
- Equipment and method for generating tomographies (P201730341).
- Microscope and method for generating 3D images of a collection of samples (ES2567379, WO2016062907, EP15851669.0, US15/521,220).
- System of detecting gamma radiation and magnetic resonance system (P201631388).

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HIGHER POLYTECHNIC SCHOOL - BIOENGINEERING AND AEROSPACE ENGINEERING

Biomedical Imaging and Instrumentation Group (BiiG)

PI: Manuel Desco Menéndez

- Optical imaging of mesoscopic tissues: theory, computation and applications in biology.
- Parametric Imaging of the Embryonic Brain: A new proposal for high-performance biomedical instrumentation.
- New x-ray Tomography Scenarios.
- Multimodal planning and guiding during breast cancer treatment and surgery.
- NECRA Project: New Clinical Scenarios with Advanced Radiology.
- Project for a Surgical Simulation Platform - SimLap.
- Cardiovascular Network (RIC).
- Technology for the inclusive study of the brain.
- Technologies for Safe and Precise Intraoperative Procedures.

R&D Regional Plan Projects (Madrid Region)

- Positron emission tomography and ultrasounds (PET/US).

Internal Projects (UC3M Funding)

- Strategic action in future biomedical technologies.
- Strategic action in translational research in biomedical imaging and instrumentation.
- Strategic action in navigation in intraoperative radiation therapy.
- Use of advanced imaging techniques in small laboratory animals for cardiovascular applications.

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Software Registrations

- FUX-SIM
- RapTor
- XAP-LAB

Technology Transfer

- The group has conducted a number of technology transfers to industry, promoting this activity with the development and marketing of several high-tech systems for experimental use in biomedical research.

Equipment

- **Medical Imaging Laboratory**
  The activity of the Medical Imaging Laboratory focuses on research on medical imaging techniques. The laboratory has one of the most complete sets of imaging equipment in the country. The range of high resolution imaging techniques comprises CT, PET, CT-PET, magnetic resonance, optical imaging and fluorescence tomography.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
HIGHER POLYTECHNIC SCHOOL - BIOENGINEERING AND AEROSPACE ENGINEERING			
Biomedical Imaging and Instrumentation Group (BiiG) PI: Manuel Desco Menéndez		**Private Funding** • Design, manufacture and supply of mannequins for sacral nerve neurostimulation navigation. • Technical viability study of the subsystems making up the integrated hybrid clinical simulation system. • Installation and tests for a navigation system for surgical applications. • New integral radiography system (INNPROVE: INNovative image PROcessing in medicine and VEterinary).	

HIGHER POLYTECHNIC SCHOOL - BIOENGINEERING AND AEROSPACE ENGINEERING

R&D GROUP

Tissue Engineering and Regenerative Medicine (TERMeG)

PI: Marcela Del Río Nechaevsky, José Luis Jorcano Noval

RESEARCH LINES

- Advanced therapies - Tissue engineering, cell and gene therapy.
- Skin regeneration: study of the molecular mechanisms involved in skin repair and regeneration and identification of new therapeutic targets.
- Study of the molecular and diagnostic bases of hereditary bullous diseases of the skin.
- Development of humanised animal models of dermatological diseases with high and low prevalence through bioengineering.
- Biology of stem cells and their use in regenerative medicine.
- Bone regeneration by tissue engineering.
- Tissue bioprinting and cellular biomechanics.

RESEARCH PROJECTS

R&D National Plan Projects

- Development of a bioactive dressing based on fibrin and active bioingredients. Fibrodress.
- Preliminary study on the safety and efficacy of the infusion of adipose tissue-derived mesenchymal stem cells for the treatment of Recessive Dystrophic Epidermolysis Bullosa.
- Biological physics of cyanobacteria differentiation.
- Research and development of smart carriers for active ingredient delivery for epidermal diseases.
- Experimental and computational methodology for the three-dimensional characterisation of cell kinetics and dynamics in tissue morphogenesis.
- Methodology for measuring intercellular forces during tissue morphogenesis.
- New therapies for rare skin diseases based on physiopathological molecular mechanisms: gene, cell and protein therapy.

R&D Regional Plan Projects (Madrid Region)

- A new generation of safer and more effective cell-based drugs, CellCam-CM.

Internal Projects (UC3M Funding)

- Strategic action in tissue engineering and bioengineering.
- Strategic action in rare skin diseases.

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TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Skin Disease Model Unit (CYBERER; Combined CIEMAT-UC3M Unit).
- Generation of models of various human pathologies through the genetic modification of stem cells or of cells from patients. These models allow designing and testing new therapeutic approaches in a human context.
- Regenerative Medicine Unit (CYBERER; Combined CIEMAT-UC3M Unit).
- Development of new cell therapy platforms for the treatment of genetic and acquired skin defects.
- Collaboration with CCSTA.
- Development of new therapeutic products in bone.
- Collaborations in Bioengineering
  Development of new products, processes and methods:
  - 3D bioprinting.
  - Mechanical transduction in the skin.
  - Non-invasive biosensors.
  - Infrared analysis of skin healing.
  - Simulation of tissues in microfluidic systems (tissue-on-a-chip).

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
HIGHER POLYTECHNIC SCHOOL - BIOENGINEERING AND AEROSPACE ENGINEERING			
Tissue Engineering and Regenerative Medicine (TERMeG) PI: Marcela Del Río Nechaevsky, José Luis Jorcano Noval		**Private Funding** • Strategic action in rare skin diseases. • Chair - Collaboration agreement between the Ramón Areces Foundation and Universidad Carlos III of Madrid. • Designer nuclease-based NHEJ-mediated gene editing for the correction of a highly recurrent COL7A1 mutation in recessive dystrophic epidermolysis bullosa epidermal stem cells. • Consultation services in the area of research and development of tissue engineering products. • Bioengineered skin transplant for skin regeneration in patients with Dystrophic Epidermolysis Bullosa.	

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - BIOENGINEERING AND AEROSPACE ENGINEERING

Jiménez Díaz Foundation Chair in Regenerative Medicine and Tissue Bioengineering

PI: Marcela Del Río Nechaevsky

Description

- The Chair is made up of Universidad Carlos III of Madrid (UC3M), the Centre for Energy, Environmental and Technological Research (CIEMAT), the Health Research Institute of the Jiménez Díaz Foundation (IIS-FJD) and the Networking Biomedical Research Centre for Rare Diseases (CYBERER).
- It focuses on developing tools and technologies that allow establishing innovative therapeutic strategies based on molecular physiopathological evidence.

Objective

- To encourage quality research that provides new directions to clinical research and, where appropriate, to medical practice in the field of regenerative medicine and tissue bioengineering.

Scope of Activity

- To enhance the biomedical research of pathologies that have no suitable treatments, particularly in the area of genodermatosis and other skin conditions, and to develop innovative therapies that may be subjected to clinical studies and trials with patients.

European Projects

a) GENEGRAFT:

- Project with a direct therapeutic application as it is a clinical trial for a rare disease, epidermolysis bullosa, where children born with the disease are known as "butterfly children." Tissue engineering and gene therapy are associated with one another within the framework of this research.

b) NanoSmells:

- This project works on wound healing and skin tissue regeneration through smells. It is a very innovative project that explores the use of artificial smells designed in a laboratory as inducing agents of the healing process.

Description of activities

- Clinical, physiopathological, cellular and genetic characterisation of genodermatoses (skin diseases of a genetic origin).
- Use of adult (mesenchymal and epithelial) stem cells in skin regeneration.
- Use of 3D arrays carrying adult stem cells for the development of humanised research models and their application in preclinical studies.
- Gene therapy:
  From the Chair, work is conducted in the area of gene therapy by means of using genetically modified adult stem cells, along two lines:
  - For use as a bioreactors of factors with biological activity.
  - For correction of the pathological phenotype in genodermatosis.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

Behaviour of Materials in Service (CSM)

PI: Miguel Ángel Martínez Casanova and Francisco Javier Velasco López

RESEARCH LINES

- Electrochemistry: Corrosion and protection.
- Surface treatment: Adhesives and coatings.

RESEARCH PROJECTS

Internal Projects (UC3M Funding)

- GRABOND: Graded adhesive bonding between dissimilar materials with healing and recycling properties.

Private Funding

- Improvement in the adhesiveness of polymeric materials by means of atmospheric plasma torch treatment for adhesive bonds.
- Treatments of polymeric materials with plasma.
- Optimisation of materials by means of using nanostructured particles and surface modification. Subproject 3: Application of nanoparticles as additives in polymeric materials.
- Development of high performance binders for diamond inserts.
- Development of machine vision systems (video extensometers) for precision measurements.
- New transparent materials for tempest-protecting critical equipment.

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Treatments with plasma
  - Types of plasmas: low-temperature, high-energy plasmas.
  - Atmospheric plasma (APPT).
- Treatments with atmospheric plasma (APPT)
  - Sterilisation of metallic surgical material and increase in wettability.
  - Long-lasting activation of polyethylene for disposable products.
  - Tissue treatment to render tissue superhydrophilic.
- Experience of natural fibres, synthetic fibres, cork... Effect on organic tissues?

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

Composite materials, Polymeric Materials and Interphases (GMCPI)

PI: Francisco Javier González Benito

- Thermoplastic nanocomposite materials with special electrical properties.
- Antibacterial thermoplastic nanocomposite materials.

Sub-lines:

- Characterisation of polymers and polymer matrix composite materials.
- Atomic force microscopy.
- Cell adhesion.
- Nano heat deformation (determination of coefficients of thermal expansion of thin films).
- Nano piezo-deformation.

R&D National Plan Projects

- New nanocomposite materials with special electrical properties and development of new characterisation methods: Nano piezo-deformation and nano heat deformation.
- Antimicrobial thermoplastic nanocomposite materials with potential applications in the food and agriculture sector (ANTIMICROPLAST).
- Prevention of diseases with antimicrobial materials in the food and health sectors.

Internal Projects (UC3M Funding)

- Strategic action in Polymeric Composite materials and Interphases.

Private Funding

- Prevention of diseases with antimicrobial materials in the food and health sectors.
- Private Funding (Crowdfunding).

Experience and Capabilities

- Preparation of materials.
- Characterisation of materials
  - Structure (DRX, FTIR, Fluorescence).
  - Morphology (MO, SEM, AFM).
  - Thermal properties (DSC, TGA, Nano heat deformation).
  - Mechanical properties (tension, bending, nanoindentation...).
  - Electrical properties (impedance, conductivity, dielectric rigidity spectroscopy, etc.).
- Materials with potential applications as pressure sensors.
- Materials for the controlled release of drugs.
- Antibacterial thermoplastics.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

Numerical Modelling, Simulation and Industrial Mathematics (GMSMI)

PI: Luis López Bonilla

RESEARCH LINES

- Angiogenesis: formation of blood vessels with applications in macular degeneration due to age, tumours...
- Formation of bacterial films (biofilms) on surfaces in contact with fluids (catheters, IVs, pacemakers, prostheses, implants, tissues, etc.) and evolution thereof (growth, expansion, reduction, disintegration...) depending on external conditions (nutrients, chemical agents, flow type, structure of the devices).
- Aggregation and movement of cell populations, schools of fish, etc.
- Graphene properties.
- Load transport and spin in electronic nanodevices. Applications to rapid devices generating truly random numbers (in collaboration with other research groups).

RESEARCH PROJECTS

R&D National Plan Projects

- Collective and stochastic behaviour in nano- and biomaterials.
- Hybrid models for nano- and biosystems.
- Non-linear transport phenomena in nanostructures.

Others

- Quantum Transport in Terahertz Detectors.
- (Mobility, NILS Programme).

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Angiogenesis models and evaluation of possible anti -or pro-angiogenic therapies. Disease models with inflammatory substrate. Statistical analysis and shape recognition (in collaboration with other research groups).
- Identification of factors which favour or hinder bacterial biofilm formation and survival in the design and use of hospital devices leading to designs and operating protocols that reduce the risk of infections derived from biofilms. In collaboration with other research groups, surface modification to eliminate already formed biofilms.
- Reduced models for the treatment of large databases and numerical code acceleration.
- Molecular dynamics simulations, Monte Carlo, lattice Boltzmann.

Technical Scientific Services

- Nanotechnology and Computational Materials Science
  - Numerical modelling and simulation of electron transport in semiconductor nanostructures subjected to intense fields.
  - Modelling of dislocations, cracks and other defects in Computational Materials Science.
  - Mechanical properties of low-dimensional solids.

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R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

Numerical Modelling, Simulation and Industrial Mathematics (GMSMI)

PI: Luis López Bonilla

Equipment

- The GMSMI has a considerable hardware and software capability to tackle numerical simulation projects. It furthermore has the capability to conduct supercomputing projects through the collaboration it maintains with CIEMAT, allowing it to have access to the parallel computing SGI Origin 3800 computer, which has 160 MIPS processors with an R14000 Gb memory and 900 Gb disc drive.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
HIGHER POLYTECHNIC SCHOOL - MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING			
Polymers and Composites **PI: Juan Baselga**	• Luminescence techniques in polymers, composites and nanocomposites. • Heat stable hybrid polymers and polymer mixtures. • Nanoreinforcements and nanocomposites • Atomistic simulation.	**R&D National Plan Projects** • Nanocomposites with hierarchically structured architectures. • Nanocomposites with functionalised particles. • Synthesis and applications of doped carbon nanotubes. **Internal Projects (UC3M Funding)** • Strategic action in Nanocomposites. • Research Line in Polymers and Composites. **Private Funding** • Surface characterisation of implant materials.	**Experience and Capabilities** • Polymer chemistry and physics. • Nanocomposites. • Chemical modification of solid surfaces. • Polymer photophysics and photochemistry. • Polymer processing. • Electromagnetic shielding. • Modification of silicas with silanes. • Polymer-grafted silicas. • Polymer-grafted aluminas. • Modification of aluminas with fatty acids · Materials for nano-reinforced polysulfone braces. · Process compatible with bio-health protocols. **Technological Offer** • Materials for electromagnetic shielding. Patent ES2509390. • Nanoreinforced polymers. Patent ES2431492, WO2013160508.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

Material Synthesis and Processing (SIPMAT)

PI: Alejandro Varez, Belén Levenfeld

RESEARCH LINES

- Ceramic or metal powder injection moulding (CIM and MIM).
- Powder extrusion moulding (PEM).
- Polymer mixes.
- Rheological behaviour of polymer systems.
- Synthesis and structural characterisation of ceramic materials.
- Biomaterials.

RESEARCH PROJECTS

European Projects

- HINMICO: High throughput integrated technologies for multimaterial functional Micro Components (MNG).
- NANOLICOM: Nanostructured Lithium Conducting Materials.

R&D National Plan Projects

- Bioactive acrylic cements: Preparation and application of composite systems for surgery and stomatology.

Private Funding

- Application of ceramic injection moulding to the manufacture of parts used in dentistry.
- Problem of nanoparticles in their production process and its application in dental implants.

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Multidisciplinary research group with vast experience in the synthesis, processing and characterisation of composite, metallic and polymeric materials.

Equipment

- The group has the technical capability and facilities to prepare both ceramic materials (ceramic, sol gel, liquid solution, mechanical grinding method, etc...), and polymeric materials. The group also has the equipment required for the structural, microstructural, electrical, thermal and mechanical evaluation and characterisation of the developed materials.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

Powder Technology (GTP)

PI: Elena Gordo, José Manuel Torralba

- Development of materials (design, processing) by means of powder technology.
- Primarily metals and metal-ceramic composites.
- Includes:
  - Production of nanoparticles.
  - Development of coatings.

R&D National Plan Projects

- Development of biofunctionalised hybrid surfaces resistant to tribocorrosion on new Ti alloys.
- Design of the microstructure and microarchitecture of metal-ceramic materials using Colloidal and Powder Metallurgy Technologies.
- PeTitNeST: High Performance Titanium by Near Net Shape Technologies.
- BIONANOFUN: BIOcomposite NANOstructured FUNctional graded materials with predictable properties for vertebrae grafts.
- Processing by the association of colloidal and powder metallurgy techniques for the design of metal-ceramic nanocomposite structures.

R&D Regional Plan Projects (Madrid Region)

- New structural and functional materials based on nanostructured and/or nanoparticle-reinforced composites.

Internal Projects (UC3M Funding)

- NANOSUP: Optimisation of materials by means of using nanostructured particles and surface modification.
- NANOMET: From metal powders to nanostructured metals and nanometals.
- ImprUDent: Improved Ultrasonic Dental devices with net shape and advanced.

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Experience and Capabilities

a) Development of Ti by PM

- Design of alloys
  - Modification of the composition.
  - Replacement of harmful elements (V).
  - Use of master alloys.
- Colloidal processing
  - Use of fine particles.
  - Design of microstructures and microarchitectures.
  - Introduction of second phases (e.g. ceramic nanoparticles).
  - Dense, porous, gradient, sheet materials.
  - Slip casting, spray-dry, pressing and sintering.
- Net-shape or near-net shape technologies
  - Conventional: processing and sintering.
  - Advanced: HIP, hot pressing.
  - Thermal treatments.

b) Magnesium for biodegradable implants

- Development of magnesium alloys with improved mechanical and corrosion resistance properties for possible applications as a biomaterial for biodegradable orthopaedic implants.

c) MIM: very small complex parts.

d) Coatings and surface modification.

e) Development of nanoparticles by means of spray pyrolysis.

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R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
HIGHER POLYTECHNIC SCHOOL - MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING			
Powder Technology (GTP) PI: Elena Gordo, José Manuel Torralba		**Private Funding** • Study of the optimal vacuum sintering cycle for producing porous 316L stainless steel coatings used in biocompatible implants.	**Technological Offer (Patents)** • Method for producing a sol-gel coating, coating composition and use thereof. • Process for producing metal and/or ceramic parts using a polysaccharide-based binding system. • Method of producing metal sponges (co-owned with the CSIC). • Low-cost titanium alloys and method for the preparation thereof. • Sol-gel coating with ceramic nanoparticles for the protection of a substrate and method for the production thereof.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - PHYSICS

IR Sensor, Remote Sensing and Imaging Laboratory (LIR)

PI: Fernando López

RESEARCH LINES

- Spectral analysis
  - Applications of infrared imaging in biomedicine.
- Thermography and radiometry
  - Biomedical applications.
- Non-invasive analysis
  - Health monitoring.

RESEARCH PROJECTS

Internal Projects (UC3M Funding)

- Strategic action in Advanced Multispectral IR Imaging Sensors.
- Line in Research, Innovation and Development of Advanced Multispectral IR Sensors.

Private Funding

- SENSIA Chair of advanced studies in Applied Optics and Infrared Sensors.

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Spectral analysis of tissues and biomolecules.
- Classification techniques using spectral images by PCA and others.
- Use of active imaging techniques (Flash Pulsed Therm., etc.) for establishing depth profiles and the detection of anomalies within tissues.
- Study of the gases produced by the human body and their relationship with different pathologies.
- Spectral capability analysis in all the visible and infrared bands.

Two methodologies:

- *Thermal analysis*
  - Active thermography expanding on already tested techniques, such as NDT (Non Destructive Testing) on living tissues.
  - The Laboratory has a skin model validated by active thermography (NDT) which allows adding internal anomalies.
- *Spectral analysis*
  - Spectral effects: The difference between the spectral signature of the different chemical (haemoglobin, glucose, ...) compounds (bonds).

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
HIGHER POLYTECHNIC SCHOOL - PHYSICS			
Nanostructured and Multifunctional Materials **PI: Ramiro Pareja**	• Biomaterials and biological materials PI: Mª Angustias Auger Martínez.	**R&D Regional Plan Projects (Madrid Region)** • Multifunctional materials for the challenges in society. **Internal Projects (UC3M Funding)** • Strategic action in advanced materials. • Strategic action in structural materials and reinforced materials. • Strategic action in the processing and characterisation of nanostructured and multifunctional materials. • Strategic action in the production and characterisation of new multifunctional materials.	**Experience and Capabilities** • Materials for melting · Processing and characterisation of: - W alloys - Cu alloys - Steels • Lightweight materials · Processing and characterisation of Al and Ti. • Hydroxyapatite-based materials.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - INFORMATION TECHNOLOGY

Computer, Communications and Systems Architecture (ARCOS)

PI: Jesús Carretero

RESEARCH LINES

- E-Health.
- Modelling and simulation.
- Big Data.
- Parallel applications and optimisation.
- High-performance computing in clusters and in the cloud.
- Mobile and distributed systems.
- Remote systems monitoring.

RESEARCH PROJECTS

European Projects

- GOVeIN European and Invoicing Project: Implementation of the European electronic invoice within the Public health
- RePhrase: Refactoring Parallel Heterogeneous Resource-Aware Applications.
  The results of this research can be applied in various fields, such as in the optimisation of applications for the diagnosis of mental diseases.

R&D National Plan Projects

- Towards unification of HPC and big data paradigms.
- Scalable data management techniques for high-end computing systems.

Internal Projects (UC3M Funding)

- Strategic action in computers and high-end computing systems architecture.
- Strategic action in the improvement of applications with high-performance heterogeneous systems.
- Strategic action in programming models for software improvement.

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- *Medical image processing*
  Parallel implementation of algorithms in GPU and CPU of an x-ray tomography simulator/reconstructor. Collaboration with large public health institutions in the development and optimisation of applications with a significant amount of data for compiling and processing data from scanners, topographies, x-rays and other medical devices. The group specialises in quasi-real time analysis and representation of data using a range of processing architectures such as multicore, GPGPU, Intel Xeon Phi.
- *Simulation of the spread of epidemics*
  · Modelling and simulation of the spread of epidemics through a realistic interconnection network based on real individual interactions extracted from social media, statistics and real data.
  - EpiGraph Tool (Scalable simulation tool for epidemiological diffusion based on social data).
  - Large scale, intensive data applications in cloud systems.
    a) Processing of diagnostic image banks.
    b) Problems of large-scale data from social media or health databases.
  - Massive data processing
    a) Parallel applications.
    b) Workflows.
  - Cloudification
    a) Taking applications to the cloud.

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R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
HIGHER POLYTECHNIC SCHOOL - INFORMATION TECHNOLOGY			
Computer, Communications and Systems Architecture (ARCOS) PI: Jesús Carretero			• *E-HEALTH* · Remote monitoring. · Remote doctor-patient communication. **Software Registrations** • FUX-SIM. • RapTor.

HIGHER POLYTECHNIC SCHOOL - INFORMATION TECHNOLOGY

R&D GROUP

Computer Security Lab (COSEC)

PI: Arturo Ribagorda, Juan Tapiador

RESEARCH LINES

- Security and e-health (medical devices implantable and biosignals).
- Digital forensics.
- Systems of cyberdefense.
- Security in smart devices (sensors, RFID, smartphones, wearables).
- Applied cryptography.
- Privacy.
- Advanced malware detection and analysis techniques.
- Hardware security (PUFs, trojan hardware).

RESEARCH PROJECTS

Actions COST

- TD COST Action TD1405 (European Network for the Joint Evaluation of Connected Health Technologies (ENJECT)).

R&D National Plan Projects

- SPINY – Security and Privacy in the Internet-of-You.
- SMOG – Security Mechanisms for Fog Computing.

R&D Regional Plan Projects (Madrid Region)

- CYBERDINE – Cybersecurity: Data, information, risks.

Internal Projects (UC3M Funding)

- Strategic action in Cybersecurity.
- Strategic action in Personal Data Protection (Security Services and Mechanisms, Cybersecurity and Digital Forensics).

Private Funding

- INDRA Chair in Cybersecurity.
- System for the cooperative preparation of friendly declarations of accidents through smart mobile devices.

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Creation of a system to reduce medication errors in hospitals and to assure the five rights of medication administration to patients.
- Security analysis in implantable medical devices (IMDs).
- Design and implementation of safety mechanisms for medical devices implantable.
- Development of systems of identification based on signal biomedical.
- Study of biomedical signals and their implications in the computer security.
- Security document for automated files containing personal data.
- Development of new cryptographic products and protocols.
- Methodology for the discovery of network vulnerabilities.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - INFORMATION TECHNOLOGY

Advanced Databases Group (LABDA)

PI: Paloma Martínez

RESEARCH LINES

- Information extraction and retrieval in the biomedical domain.
- Application of information retrieval and extraction techniques to biomedical texts, particularly in the detection of biomedical entities (such as drugs, genes and proteins) and associations between these entities (drug-drug interactions, therapeutic targets).

RESEARCH PROJECTS

European Projects

- TrendMiner: Large-scale, Cross-lingual Trend Mining and Summarisation of Real-time Media Streams.

R&D National Plan Projects

- Extraction of multilingual information in healthcare and its application to scientific and informative documentation- extraction of information.

Internal Projects (UC3M Funding)

- Strategic action in applying language technologies to the extraction of information in different domains and to content accessibility.
- DDIExtraction: Extraction of Drug-Drug Interactions from BioMedical Texts.
- QUEST: Quality of life system Enabling Senior Travel.

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Extraction of pharmacological interactions from biomedical texts.
- Extraction of information relating to drugs, diseases and adverse effects.
- Automatic semantic analysis of healthcare information (clinical notes, scientific publications, etc.).
- Answer search system for Spanish applied to medical texts.

Software Registrations

- DrugDDI Corpus.
- DrugNer Corpus.
- DrugNerAr Corpus.
- Information extraction system in the pharmacological domain.

Applications

- Support for ICD9/10, SNOMED, CT, CIMA, MedDRA coding, etc.
- Human operator help systems: coding processes (e.g. diagnoses in ER release forms).
- Medical event monitoring (adverse reactions, treatments, etc.) in different media (blogs, social media, etc.).

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
HIGHER POLYTECHNIC SCHOOL - INFORMATION TECHNOLOGY			
Applied Artificial Intelligence Group (GIAA) **PI: José Manuel Molina, Jesús García**	• Machine vision. • Knowledge engineering. • Contextual Information and Data Fusion Systems. • Agent and Multi-agent Systems: web, information retrieval, recommendation, e-commerce, management of sensors.	**Internal Projects (UC3M Funding)** • BONES: Bones-Osteocytes dyNamics - Exploiting Self-organising algorithms. • da-MEDIS: Big Data-analytics Medical Decision and Integrated Health Care Support System. • MEDIAN: MEdical citizenship trough Data Analytics. • ACEES: Agent based hybrid cloud for Emergency Systems.	**Experience and Capabilities** • Smart Information Management (Data Mining, Dashboards, DSS, Hierarchical Analysis). • Environmental Intelligence. • Automatic Behaviour Analysis based on Video Sensors. • Advanced Vision Systems.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
HIGHER POLYTECHNIC SCHOOL - INFORMATION TECHNOLOGY			
Knowledge Reusing **PI: Juan Llorens**	• Model-driven software development. • Process and project management. • New technological innovation methods. • Organisation of processes for reusing. • Software process measurement. • Knowledge representation. • Knowledge retrieval. • Knowledge reusing.	**R&D National Plan Projects** • Automatic generation of an oncology ontology. **Private Funding** • On-line course for the development of projects for improving patient safety and the implementation of good practices in healthcare centres. • Course on risk management and improvement of patient safety. • Design and development of a semantic engine. • Services for hosting web content and technical assistance for the on-line training platform in standardising the clinical content of the medical record in the National Health System.	**Experience and Capabilities** • Electronic clinical data management. Solutions: · Implementation of search engines. · Development of data intensive software applications. • Software improvement. • Handling a large amount of data. • Solutions: · Complex technologies for structured information representation. · Search engines. · Decision support systems.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
HIGHER POLYTECHNIC SCHOOL - INFORMATION TECHNOLOGY			
Planning and Learning (PLG) **PI: Daniel Borrajo**	• Artificial Intelligence. • Social Robotics and Assistive Robotics. • Task Planning. • Automatic Learning. • Problem solving. • Decision Support Systems.	**European Projects** • CLARK- Smart Clinic Assistant Robot for CGA. • European Clearing House for Open Robotics Development Plus. **R&D National Plan Projects** • Design, automatic planning and evaluation of neurorehabilitation therapies led by an interactive social robot. • Lifelong technologies for social robots in smart homes. • THERAPIST: An autonomous and socially interactive robot for motor and neurorehabilitation therapies.	**Experience and Capabilities** Development of Motor Rehabilitation Therapies and Geriatric Evaluation with Humanoid Robots: • *CLARK* · CLARK proposes the development of a hospital infrastructure that allows the geriatric evaluation of patients. The infrastructure is made up of an interactive social robot, along with the information system required for daily management of the infrastructure, generation of reports, etc. • *NAO Therapist* · NAO Therapist proposes a new therapeutic motor rehabilitation tool for children in which an interactive and fully autonomous social therapeutic robot is capable of sensing the patient's reactions and determining whether or not the patient is doing their exercises correctly. It is an innovative method that would help improve patient recovery time and streamline the tasks of medical professionals.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
HIGHER POLYTECHNIC SCHOOL - INFORMATION TECHNOLOGY			
SOFTLAB **PI: Ángel García Crespo**	• Biometrics: Security, Accessibility. • Application integration. • Database technologies. • Data modelling techniques.	**R&D National Plan Projects** • TRAZAMED: Integral platform based on RFID and DATAMATRIX identification technologies for the traceability of medicinal products. **Internal Projects (UC3M Funding)** • OMEGA: Open Mobile e-Health Services Platform based on Linked Data for the Medical Cross-Domain. **Private Funding** • PreMyTECD: Integral multi-device platform for the prevention, monitoring and treatment of chronic degenerative diseases based on semantic technologies, data mining and collective intelligence.	**Experience and Capabilities** • *IRIS Laboratory* · The laboratory facilities have been used to host a large number of research projects which utilised the lab's connectivity capabilities and its available equipment.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - MECHANICAL ENGINEERING

MAQLAB: Machine Laboratory

PI: Juan Carlos García Prada, Cristina Castejón

- Kinematic and dynamic synthesis and analysis of machines and mechanisms. Machine maintenance and diagnostics.
- Application to medical devices.
- Computer-aided design, analysis and simulation. MEF and SEM.
- Rapid prototyping, 3D printing.
- Robotic elements.
- Magnetomechanics and Nanomechanics.
- Instrumentation and experimental methods.
- Plant biomechanics.

Internal Projects (UC3M Funding)

- Strategic action in advanced research in industrial engineering of machines and mechanisms.

Experience and Capabilities

- The MAQLAB group performs research, development and innovation tasks in the field of mechanical engineering. Its activities include research projects relating to advanced mechanisms, special mechanisms, magnetomechanics, applied tribology, biomechanics and monitoring and measurement techniques, with mechanism, mechanical device and machine design, analysis, simulation and prototyping capability.

Technological Offer

- BIOPUNCH: automatic device for performing skin biopsies.
- Patent P201331644 (co-owned with Hospital Ramón y Cajal).
  - Proposed mechanism.
  - Primary verification of behaviour with analytical models.
  - Patented design.
  - Test prototypes made to scale with a 3D printer.
- Therapeutic cutlery.
  - Design, improvement and optimisation.
  - Prototype (3D printer).
- Rectoscope.
  - Spanish Patent P201630551 (co-owned with Hospital La Paz. April 2017: PCT filed).
  - Design and prototype done.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - MECHANICAL ENGINEERING

Mechanical and Biomechanical Component Manufacture and Design Technologies (FabDis)

PI: Henar Miguélez Garrido

RESEARCH LINES

- Numerical modelling of mechanical processes by means of finite element codes.
  - Implementation of constitutive models.
  - Model damage and failure.
- Behaviour of mechanical components at fatigue and fracture.
- Machining of advanced materials (Ti alloys/composites).
- Prototype design and manufacture.
- Tool design and manufacture.
- Biomechanical component design.

RESEARCH PROJECTS

Internal Projects (UC3M Funding)

- Strategic action in advanced manufacturing technologies.
- Research line in modelling of prototype machining and manufacture.
- DATES: Interaction and damage of the system of n deformable bodies of different nature.
- HSREMNi: analysis of high speed Ni alloy removal processes.

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Development of surgical devices and manufacture of prototypes.
- Device for enhancing muscles using ultrasounds.
- Redesign of a pump device for pumping blood from the ventricle to the atrium (collaboration between GMF-UC3M).
- Computer-aided design, manufacture and engineering: CAD-CAM-CAE.
- Resistant analysis.
- Manufacturing oriented design.
- Damage identification techniques.
- Applications of ultrasound:
  - EchoPIV: determination of velocity fields by means of tracking ultrasound contrast agents (UCAs) in ultrasound images. Mathematical modelling.
  - Non-invasive measurement of pressure *in vivo*.
- Cell mechanics (collaboration between GMF and UC3M).

Equipment

- Work stations and finite element numerical simulation software.
- Behaviour subroutines for an internally developed material.
- Machine tools: machining centre, CNC lathe.
- Mechanical element test benches, measurement systems.
- Commercial numerical calculation tools for fluid mechanics processes.
- Installations for experimental characterisation of fluid mechanics processes.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
HIGHER POLYTECHNIC SCHOOL - TELEMATIC ENGINEERING			
ADSCOM (Advanced Switching and Communication Systems) **PI: David Larrabeiti**	• Adaptive system communication middleware design.	**European Projects** • MyUI: Mainstreaming Accessibility through Synergistic User Modelling and Adaptability. • ReCRED: From Real-world Identities to Privacy-preserving and Attribute-based CREDentials for Device-centric Access Control. **Internal Projects (UC3M Funding)** • HEALTHYLIFE: Motivational and personalised system for promoting HEALTHY coproductive LIFEstyle. • INPROFOR: Intelligent Searching and Processing of Multimedia Information for Forensic Purposes, using Data and Privacy Protection.	**Experience and Capabilities** • Development of middleware for accessible distributed adaptive systems. • Network user modelling for adaptive applications in television sets, computers and mobile terminals.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - TELEMATIC ENGINEERING

GRADIENT (Educational Technologies Laboratory)

GAST Group

PI: Carlos Delgado Kloos

RESEARCH LINES

- E-Learning.
- Real and mixed virtual environment (2D/3D) training simulators.
- Modelling systems that aid in the editing, deployment and evaluation of learning experiences.
- Training gamification. Serious indoor and outdoor games.
- Mobile learning. Augmented indoor and outdoor learning experiences using tags.
- Automatic learning (machine learning) based on data from wearable (physiological, motion and location) sensors.
- Recommendation systems for helping to self-manage health.
- Algorithms for supporting rehabilitation based on data from wearable sensors.
- Assistive technologies.
- Adaptive interfaces.
- Motivation in fragile people with chronic diseases.
- Prediction of situations requiring the intervention of a healthcare professional after the detection of patterns in sensed data from wearable sensors.

RESEARCH PROJECTS

R&D National Plan Projects

- UNICARE: Universal health monitoring and intelligent care for a connected society powered by crowd-sensing learning and adaptation to each individual via noninvasive but pervasive sensing.
- REMEDISS: Sensorised medical network that allows remote, in-home patient monitoring by means of taking and sending vital sign measurements and physiological parameters by means of standard interfaces and conventional electronic devices.

Internal Projects (UC3M Funding)

- CACUMA: Social Collaborative Authoring, Curating and USe of Educational Materials.
- PhyMEL-ICT: Physical, Mental and Emotional Learning supported by Information and Communication Technologies.

Private Funding

- Adaptation of the Phymel methodology to clinical training through the use of simulators.
- Study on adapting e-learning platforms for medical simulation.

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Modular and flexible expeditious design of learning experiences in real virtual and mixed environments based on existing courses through the use of templates and simulation engines.
- Design of games, storyboards and interaction for skill-based training and evaluation: learning objectives, missions, rewards and analysis.
- Design of training experiences in situ based on mobile learning.
- Design of training experiences using augmented reality.
- Use of gamification techniques in technology-led learning environments.
- Design and validation of automatic learning algorithms for the self-management of health.
- Development of personal recommenders.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
HIGHER POLYTECHNIC SCHOOL - TELEMATIC ENGINEERING			
Pervasive Computing Laboratory Telematic Applications and Services Group (GAST) **PI: Celeste Campo Vázquez, Carlos Delgado Kloos, Carlos García Rubio, Andrés Marín López, Mario Muñoz Organero, Luis Sánchez Fernández**	• Security in ubiquitous computing. • Pattern extraction and anomaly detection. • Design and development of mobile applications. • Indoor locating. • Internet of Things (IoT). • Management of dynamic patient consent in case of emergencies: event-activated credentials. • Flexible and efficient medical record management systems. • Id management (IdM) and access control. • Attribute-based encryption. • Cybersecurity.	**R&D&I National Plan Projects** • INRISCO: INcident monitoRing In Smart COmmunities. • EMRISCO: EMergency Response In Smart COmmunities. **Internal Projects (UC3M Funding)** • Strategic action in Ubiquitous Computing Security. • PROTRUST: Private, Secure, Trustworthy Management of User Profiles in Social and personalised Information Systems. • Strategic action in Ubiquitous computing.	**Experience and Capabilities** • Solutions for improving user privacy in medical record management. • Detection of anomalous behaviours in movements of users in an individual and collective manner. • Experience in design and development of mobile applications. • Precise indoor user location and prediction of the next location. • Detection of profiles and false information spread over social media.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
HIGHER POLYTECHNIC SCHOOL - THERMAL ENGINEERING AND FLUID ENGINEERING			
Fluid Mechanics (GMF) **PI: Antonio Luis Sánchez**	• Biofluid dynamics: · Study of flows in the human body, particularly in the circulatory system. · Minimally invasive techniques for the diagnosis and treatment of vascular pathologies, such as the use of microbubbles as a contrast agent in ultrasound diagnosis.	**R&D National Plan Projects** • Development of a non- invasive pressure measurement technique based on the analysis of the acoustic spectrum of microbubbles. • Mechanisms for the generation of microdroplets and microbubbles that can be applied to industrial, pharmacological and medical processes.	**Experience and Capabilities** • The GMF has expertise in using analytical, numerical and experimental techniques for solving thermal fluid dynamic problems. Biological flows.

HIGHER POLYTECHNIC SCHOOL - SYSTEMS AND AUTOMATIC ENGINEERING

R&D GROUP

Robotics Laboratory (Robotics Lab)

PI: Miguel Ángel Salichs, Carlos Balaguer, Luis Moreno

RESEARCH LINES

- Robotic system design.
  - Customised mechanics, hardware, software, control, actuators and sensors.
- Handling and locomotion.
  - Gripping, strolling, cooperation (hands-arms-legs-sight).
- Robot-human interaction.
  - Cognitive systems, multimodal interfases (sight, speech, touch, strength).
- Personal and assistive robots.
  - Elderly, disabled, children with problems, Alzheimer's.

Specific Research Lines in Health:

- Assistive robotics: usability and control interfases.
- Assistive robotics to improve the quality of life of the disabled and the elderly in hospital environments (eating, drinking, handling things, personal hygiene) by means of "accessible robots".
- Medical instrument guidance.
- Guidance of healthcare instruments used inside the body with stereotaxic techniques.
- Development of technical aids and support products.

RESEARCH PROJECTS

European Projects

- MONARCH: Multi-Robot Cognitive Systems Operating in Hospitals (MGMT).

R&D National Plan Projects

- Applications of social robots.
- ARCADIA: Cognitive robotic assistant for people with special needs.
- Hybrid neuroprosthetic and neurorobotic devices for functional compensation and rehabilitation (HYPER).
- Development of robotic exoskeletons for the rehabilitation of an upper limb.
- Development of social robots for helping the elderly with cognitive deterioration.
- Extension of cognitive and semantic capabilities to robot navigation in outdoor environments.
- Robotised inspection of the healthcare personnel protection suits in relation to the high-level isolation of patients, including Ebola.
- Robohealth-a: Development of patient assistance robots to improve their quality of life.

R&D Regional Plan Projects (Madrid Region)

- COMANDER: Safe and multimodal cooperation with robotic assistants for people with special needs.
- RoboCity2030-III-CM. Robotics applied to the improvement of the quality of life of citizens.
- Service robots for the improvement of the quality of life of citizens in metropolitan areas.

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Development of robotised support systems and medical devices for clinical and surgical environments: exoskeletons, prostheses, etc.
- Development of patient assistance robots in hospital and rehabilitation environments and their user-friendly control and handling systems.
- Fusion of sensory information: vision, strength, speech, touch, gestures, etc.
- Right-handed manipulation of devices and their control: algorithmics and implementation.
- Applications of new soft robotics & biocompatible materials: smart sensors & actuators.

Patentes

- Portable electromechanical assistance device (ES2415304).
- Indicator device (ES2325976).

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
HIGHER POLYTECHNIC SCHOOL - SYSTEMS AND AUTOMATIC ENGINEERING			
Robotics Laboratory (Robotics Lab) PI: Miguel Ángel Salichs, Carlos Balaguer, Luis Moreno		**Internal Projects (UC3M Funding)** • Strategic action in exoskeletons and advanced robotics. • Strategic action in assistive robots and systems. • APTITUDE: Advanced robotic systems integration in intelligent home and hospital environments to improve the independence of the elderly in DLAs. • CORWEL: Cognitive Robots Living With The Elderly. • CO-SAPIENt: COllaborative and Smart robotic platform to Assist and help medical staff and Patients to Improve transportation and accommodation in hospitals. • STABILE: Smart Emotion Identification and Regulation in the Ageing Adult through Ambient Intelligence and Emotional Robotics. • STARS PARKINSON: Smart TherApeutic Robots and Spaces for Parkinson's Disease. **Private Funding** • Development of a surgical system for the positioning and guidance through non-linear paths controlled by means of stereotaxic techniques. • WRG Robots and Technology Chair.	

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - SYSTEMS AND AUTOMATIC ENGINEERING

Intelligent Systems Laboratory (LSI)

PI: Arturo de la Escalera, Jose María Armingol, Francisco José Rodríguez

RESEARCH LINES

- Computer vision.
- Perception systems.
- Pattern recognition.
- Artificial intelligence.

RESEARCH PROJECTS

R&D National Plan Projects

- ORCA: Order Invariant Classification of Sets Using Recurrent Neural Networks.

Internal Projects (UC3M Funding)

- Research Line in Intelligent Systems.

Private Funding

- Image processing and analysis viability.
- VISION: New Generation Video Communications.

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Object recognition.
- Action recognition (deep learning).

HIGHER POLYTECHNIC SCHOOL - MATHEMATICS

Interdisciplinary Complex Systems Group (GISC)

PI: José A. Cuesta

RESEARCH LINES

- Statistical mechanics and non-linear dynamics.
- Materials and nanostructures science.
- Microfluidics and fluid adsorption in structured substrates.
- Theoretical ecology.
- Behaviour and social complexity.
- Evolutionary dynamics.
- Systems biology.
- Complex fluids.
- Granular media.

RESEARCH PROJECTS

European Projects

- Bridging the gap: from Individual Behavior to the Socio-tEchnical MaN (IBSEN). FET-Open, H2020.

R&D National Plan Projects

- Self-organisation and fluctuations versus growth, erosion and delamination.
- Variation, replication and adaptation in evolutionary processes (VARIANCE).
- Complex fluids and their interphases.
- Non-linear statistical and dynamic mechanics of biological and social systems.
- Biological physics of cyanobacteria differentiation.
- Physics of the differentiation and the formation of nitrogen fixing cell patterns in cyanobacteria.

Private Funding

- The Dunbar numbers and the structure of digital societies: modelling and simulation (DUNDIG).

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Design of solutions for the control of dynamic and variable processes which involve large volumes of data (genomics and proteomics).
- Complex network analysis. The group has a wide range of mathematical techniques for extracting information from systems described with networks (e.g. bio-health systems) providing important indications for their operation.
- Mathematical models for predicting fluid equilibrium and dynamic properties of complex fluids, such as liquid crystals and colloidal suspensions.
- Theoretical and experimental study of vibrated granular particle monolayers with an emphasis on the role of entropy in the formation of spatial patterns.
- Big "Complex/Social" Data detection, management and prediction of behaviours, opinions and the diffusion of information in social media.

Possible health-related applications:

- Using Big Social Data for the early detection of health-related behaviours in social media.
- Modelling of advanced materials in nanotechnology: selective growth of cellular aggregates and biocompatible materials.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
HIGHER POLYTECHNIC SCHOOL - MATHEMATICS			
Theoretical and Computational Biomedical Image Group **PI: Miguel Ángel Moscoso**	• Diffuse optical tomography. • Molecular imaging. • Microwave imaging for the early detection of breast cancer. • Inverse problems. • Wave propagation in biological tissues.	**European Projects** • Integrated Technologies for In vivo Molecular Imagingbb. **R&D National Plan Projects** • High-throughput 3D optical imaging with phase information in *in vivo* microscopy. • Optical imaging of mesoscopic tissues: Theory, computation and applications in biology. • Computational models for non-invasive image reconstruction techniques of interest in biomedicine. • Direct and inverse problems in biophotonics. • Efficient numerical algorithms for images with microwaves: applications to the early detection of breast cancer. **Internal Projects (UC3M Funding)** • Strategic action in inverse and imaging problems. **Others** • Image Reconstruction Algorithms for Optical Diffusion Tomography with Large Data Sets Using the Radiative Transport Equation *Funding: NSF* • A Mathematical Investigation of Light Propagation in Tissues for Physiological Monitoring and Tissue Imaging *Funding: NSF*	**Experience and Capabilities** • Development of new mathematical and computational algorithms for image reconstruction based on contour data . • Diffuse optical tomography, optical molecular imaging and microwaves imaging for the early detection of breast cancer. • New approaches for image formation in biomedicine. • Evaluation of the precise modelling of wave propagation in tissue (direct problem) and efficient image reconstruction strategies (inverse problem). • System and method for the reconstruction and display of cardiac electrical activation.

HIGHER POLYTECHNIC SCHOOL - ELECTRONICS TECHNOLOGY

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
Mixed-Signal Integrated Circuits Design Lab (MSIC) (Microelectronic Design and Applications Group, DMA) **PI: Luis Hernández**	• Ultra low consumption circuit miniaturisation. • More efficient circuits and systems, processing according to biological models.	**R&D National Plan Projects** • Time-referenced data acquisition interfaces for sensors, medical imaging and communications. **R&D Regional Plan Projects (Madrid Region)** • Ultra-low power A/D converters based on Dual Slope Sigma-Delta modulators for biomedical sensors. **Private Funding** • Development of a bandpass DS modulator for medical instrumentation. • Development of new ADC (Analog-Digital Converter) architectures for biosensor interfaces. • Design and characterisation of the main building blocks of ADCs for medical instrumentation. • Feasibility study of the bandpass Sigma-Delta modulator for medical instrumentation.	**Experience and Capabilities** • Conception, design and development of data converters: Applications: · Communications (online, wireless). · Sensors. · Biomedicine. • Complete application-specific intergrated circuit or ASIC design flow. • Design and development of low power consumption-specific and/or high scalability-specific circuits in different CMOS technologies. **Experience in the biomedical field** • Collaborative Research Programme (UC3M-IMEC) focused on the following fields: · Multi-standard readout circuits for EEG-ECG. · Analog-digital converter design. · Biopotential readout sensor and circuit design. • Project with AMS (European semiconductor company) · Integrated receiver for MRI. · Concept receiver development. · Analog-digital converter design.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - ELECTRONICS TECHNOLOGY

Photonic Displays and Applications (GDAF)

PI: José Manuel Sánchez Pena, Carmen Vázquez

RESEARCH LINES

- Electro-optic devices and applications.
- Photonic devices for optical networks: MUX, routers, attenuators, interleavers.
- Advanced instrumentation and sensors
  - Nanosensors
  - instrumentation and monitoring with optical fibres.
- Assistive technologies: Research and prototypes in technologies relating to health and well-being.
  - Microcontrolled electronic/optical systems -> different disability profiles.
  - Reduced vision support products (RA, RV).

RESEARCH PROJECTS

R&D National Plan Projects

- A new generation of photonic devices based on self-organised materials: characterisation.
- Sustainable technologies for sensing and communications based on optical fibres in the area of transport and biomedicine.

R&D Regional Plan Projects (Madrid Region)

- SINPHOTON-CM. Sensors and Instrumentation in Photonic Technologies.

Internal Projects (UC3M Funding)

- Strategic action in the development of electro-optical systems for biomedical, healthcare and industrial applications.

Private Funding

- LED-based output signalling system for athletes with a hearing disability.
- Indra-Adecco Foundation Chair in accessible technology.
- Social CRM: Design, analysis and prototyping of a dependent TIC platform for a general public help line.

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Active filters: electrochromic (EC)
  Application: EC glasses for patients with low vision.
- Augmented reality for patients with residual vision and anopsias
  Application: vision rehabilitation
- Intracellular sensor based on resonant nanoparticles.
- Non-invasive temperature sensors.
- Self-referenced sensor networks based on biocompatible micro-structured polymeric fibres.
- Designs of highly selective resonance ring structures for potential identification of tumours in systems (lab-on-a chip).

HIGHER POLYTECHNIC SCHOOL - ELECTRONICS TECHNOLOGY

R&D GROUP

Instrumentation Laboratory

(Optoelectronics and Laser Technology Group, GOTL)

PI: Pablo Acedo

RESEARCH LINES

Optoelectronic instrumentation

- Design and development of optoelectronic instrumentation systems and laser systems: from the hardware to the processing algorithms and integration of the user interface.
- Main applications: scientific instrumentation, spectroscopy, biomedical instrumentation.

Optical sources/optical signal synthesis

- Design and characterisation of photonic architectures for the generation, processing and detection of multimode coherent sources (optical frequency comb generators) millimetric signals and THz.
- Main applications: spectroscopy, industrial and biomedical applications.

RESEARCH PROJECTS

European Projects

- CELTA: Convergence of Electronics and Photonics Technologies.
- Photonic of microwaves and THz: techniques and integration for the generation and applications.

R&D National Plan Projects

- Multimode photonic sources for spectroscopy and fibre optic sensor interrogation.
- Improved performance in terahertz generation systems: increase in maximum frequencies and usability.

R&D Regional Plan Projects (Madrid Region)

- Multimode photonic sources for spectroscopy and fibre optic sensor interrogation.
- Conception and design of an optical diagnostic system for breast cancer using infrared laser diodes.

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Instrumentation systems development.
  - Development of the complete system:
    - Laser emitters.
    - Detectors.
    - Lighting optics.
    - Preamplification and conditioning.
    - System integration in FPGAs.
    - Classification algorithms based on SVMs. Neural Networks, PCA, ICA, etc.
- Diffuse Reflectance Spectroscopy System for Early Vascularization Assessment (non-invasive, non-contact, *in vivo*).
  - Development of a contactless system for the evaluation of vascularisation in artificial skin implants (Collaboration with CIEMAT).
- Metabolite Detection (*in vivo,* non-invasive).
  - Development of spectroscopic systems for the detection of metabolites in non-invasive schemes (through the skin). Collaboration with Frankfurt University/CIEMAT.
- Detection of hyperglycemic states in diabetic mouse models.
  - Detection of non-invasive and low-cost hyperglycaemia in animal models.
  - Insensitive to the type of animal, skin, state of hydration, etc.
- Optomicrofluidics for *in-vitro* Metabolite Detection.
  - Development of Point-of-Care Systems based on optomicrofluidic heads for the detection of metabolites and other compounds of interest.
  - Use of fluorescence techniques and multimode optical sources.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS

HIGHER POLYTECHNIC SCHOOL - SIGNAL THEORY AND COMMUNICATIONS

Machine Learning for Data Science (ML4DS)

PI: Jerónimo Arenas

- Applications of machine learning in magnetic resonance imaging (MRI) of the human brain, particularly in spectroscopic, structural and functional MRI.
- The group develops techniques for the detection and characterisation of mental disorders and techniques for the functional mapping of the brain as alternatives to the standard SPM.

R&D National Plan Projects

- Automatic learning of characteristics and metrics that can be interpreted for computational intelligence.

Internal Projects (UC3M Funding)

- ANIMA: Analysis of NeuroImage through Machine learning Algorithms for understanding of mental disorders.

Private Funding

- Development of algorithms for the multivariate analysis of structural neuroimaging data for Project 11F1S038 (CP10/00604).

Experience and Capabilities

- Characterisation of mental disorders by means of neuromarkers extracted from neuroimages
- Fusion of different sources of information for characterising mental disorders
  - sMRI.
  - fMRI.
  - Gene arrays.
  - Psychological tests.
- Design of neuromarkers on sMRI/fMRI for other pathologies.
- Application of the neuromarker methodology to another type of medical imaging.
- Time series analysis (extension of spatial relations between voxels to temporal relations between samples of the series): Search for critical segments in a set of time series.
- Fusion of homogenous sources of information.
- Optimisation/adaptation of the application of automatic learning algorithms to any database.
- Automatic learning for Big Data.

HIGHER POLYTECHNIC SCHOOL - SIGNAL THEORY AND COMMUNICATIONS

R&D GROUP

Signal Processing and Learning (GTSA)

PI: Antonio Artés

RESEARCH LINES

- Signal detection and classification.
  - Parametric and non-parametric, centralised and distributed.
  - Biological signal classification.
- Machine learning for signal and image processing.
  - Design of (discriminative and generative) classifiers and estimators.
  - Extraction of discriminative information for classification and estimation.
  - Data mining in healthcare, genetic and supporting databases for experiments.
- Advanced signal and image processing techniques.
  - Non-linear filtering, high dimensional complex systems.
  - System simulation.
- Information theory.
  - Wireless system performance limits.
  - Data compression.

RESEARCH PROJECTS

European Projects

- Machine Learning for Personalized Medicine (MLPM).

R&D National Plan Projects

- Anomalous human behavlour Detection (AID).
- Advanced Bayesian computational methods for estimation, prediction and control in complex multisensory systems (ADVENTURE).

R&D Regional Plan Projects (Madrid Region)

- Environment and Genes in Schizophrenia (AGES).
- Intelligent Systems: Concepts and Applications.

Private Funding

- Epileptic seizure detector with inertial sensors.

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- *Psychiatry:*
  - Determination of underlying causes and discriminatory factors in mental diseases (based on healthcare and genetic data).
  - Characterisation of behaviour by means of devices "wearable".
  - Progression of psychiatric disorders.
- *Neurology:*
  - EEG processing in Man-Machine Interfaces.
  - Portable functional imaging from an EEG.
  - Monitoring epileptic seizures.
- *Cardiology:*
  - Causality measurements for detecting activation focal points in atrial fibrillation.
  - Simulation of mechanisms for the generation and maintenance of atrial fibrillation.
  - Outpatient monitoring by means of: inertial sensors, ECG, EEG, GSR, and imaging.

Patents

- System and method for automatic detection of circular cardiac activations (P201731161). Co-ownership UC3M / FIBHGM.

Equipment

- Data collection system data for clinical trials.

HIGHER POLYTECHNIC SCHOOL - SIGNAL THEORY AND COMMUNICATIONS

R&D GROUP

Multimedia Processing (GPM)

PI: Fernando Díaz de María

RESEARCH LINES

- Machine vision.
- Diagnostic aid systems.
- Brain tumour classification.
- Early diagnosis of melanomas.
- Quantitative alopecia tracking.
- Speech processing applications.

RESEARCH PROJECTS

R&D National Plan Projects

- Annotation, indexing and coding of user-generated content.
- Salience and attention: multimodality, context-awareness, self-adaptation and bio-inspiration.

Internal Projects (UC3M Funding)

- Strategic action in Human Cognition Modelling and Applications (MoCHA).
- TCoTCo: Towards Cognition Through Computation: an idempotent interpretation of perception and cognition.

Private Funding

- Context-aware automatic speech recognition under cognitive stress aided by multimodal biometric detection.

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- *Machine vision:*
  - Diagnostic aid systems.
  - Brain tumour classification.
- Expert knowledge: relevant characteristics for diagnosis.
  - Early diagnosis of melanomas.
    - Automatic diagnostic test determination/ prioritisation.
    - Analysis of congruence of the tentative diagnosis and the characteristics of the image.
    - Retrieval of similar cases.
    - Training system for new specialists.
  - Quantitative alopecia tracking.
- *Speech processing* applications for neurological diseases:
  - Parkinson's Disease
    Based on the analysis of the recorded speech of patients of this type, it is possible to develop a system to help predict the severity of Parkinson symptoms that is less expensive than the clinical analyses used today.
    It has a possible application to the remote follow-up of the progression of the disease and/or efficacy of the medication in patients.
  - Alzheimer's Disease
    By means of analysing the spontaneous speech of patients, it is possible to develop automatic systems to help in the diagnosis for this type of disease.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
SCHOOL OF SOCIAL AND LEGAL SCIENCES - ECONOMICS			
Economics of Health and Medicine **PI: Félix Lobo**	• Economics of healthcare and health. • Economics of medicine and the pharmaceutical industry. • Economic analysis of the health services law. • Hospital and other health services management and administration. • Fundamental health rights. Ethics of healthcare. • Administrative health law. • Sociology of health professions and services.	**Private Funding** • AbbVie-UC3M Chair in economics of medicine. • Creation of an area of health economics and policies in Funcas. • Innovative drugs and public budgets in Spain: future outlook. • ABBOTT Chair in economics of medicine. • Economic evaluation study of an *in vitro* test for haematological diseases.	**Experience and Capabilities** • Chair in economics of medicine, Universidad Carlos III of Madrid - ABBVIE *It is created in 2009 to encourage post-grad education and research in the field of social sciences applied to medicines.* · Studies from the macroeconomic viewpoint. • Magnitude and progression of the pharmaceutical expenditure. • State-sponsored price intervention. · Studies from the microeconomic perspective. • Techniques for the economic evaluation of medicines.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
SCHOOL OF SOCIAL AND LEGAL SCIENCES - STATISTICS			
Statistical Modelling and Data Analysis **PI: Daniel Peña Sánchez de Rivera**	• Heterogeneity in statistical models and model selection. • Size reduction methods. • Bootstrapping methods. • Bayesian estimation.	**R&D National Plan Projects** • "Big data" and complex data in Business and Finance. • Advanced statistical methods for complex data. • Robust methods for the statistical analysis of data with a complex structure. **Internal Projects (UC3M Funding)** • PEARL: Programme Enhancing Adolescent Resilience for Life. • Statistical methods based on functional data and high dimensional data with applications in finance and biostatistics.	**Experience and Capabilities** • Biostatistics. • Bioinformatics.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
SCHOOL OF SOCIAL AND LEGAL SCIENCES - STATISTICS			
Non-parametric Computation-intensive Techniques in Statistics **PI: Juan Romo Urroz**	• Analysis, classification and processing of functional and very high dimensional data. • Bootstrapping techniques. • Survival analysis. • Robust statistical methods and processing of atypical data. • Genomics. • Big Data.	**R&D National Plan Projects** • "Big data" and complex data in Business and Finance. • High-precision poverty mapping. • Flexible smoothing methods and efficient algorithms in epidemiology, demographics and the environment. • Generalised additive models for complex and high dimensional data. **Internal Projects (UC3M Funding)** • Strategic action in multidimensional smoothing models. **Private Funding** • GLMs applied to the calculation of the death rate.	**Experience and Capabilities** • The group of research can collaborate in the analysis of data complex: curves, microarrays or images. • The research group has the computer infrastructure for process large data sets (data mining) or for implementing computation-intensive statistical techniques (bootstrapping, bagging, boosting, etc.). • The research group generates state-of-the-art statistical methodology for processing biomedical data.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
SCHOOL OF SOCIAL AND LEGAL SCIENCES - INTERNATIONAL LAW, ECCLESIASTICAL LAW AND THE PHILOSOPHY OF LAW			
Human Rights, Rule of Law and Democracy **PI: Rafael de Asís, Fco. Javier Ansuátegui**	• Bioethics. • Bioethics and sexual and reproductive rights. • Biorights as a new category of human rights. • Patient rights. • Clinical research in human beings. • Science, biotechnology and human rights. • Professional ethics and deontology.	**R&D National Plan Projects** • Accessibility and non-discrimination of the disabled in public spaces. • Impact of the international convention on the rights of the disabled in the Spanish law system. • Problems with euthanasia. **R&D Regional Plan Projects (Madrid Region)** • Qualitative and quantitative study of the information received by cancer patients in the hospitals in the Spanish region of Madrid. **Internal Projects (UC3M Funding)** • Clinical trials: implications for society. **Private Funding** • FIPSE study on random discrimination of people with HIV or AIDS. • Chair in ethics in business and in the professions.	

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
SCHOOL OF SOCIAL AND LEGAL SCIENCES - LAW PUBLIC OF THE ESTADO			
Services of General Interest, Economic and Public Intervention **PI: Tomás de la Cuadra Salcedo**	• Provision of free market public assistance. • Provision of non-economic public services. • Healthcare, education and social services.	**R&D National Plan Projects** • The future of the welfare state in the European Union: a common essential public services model across Europe. **R&D Regional Plan Projects (Madrid Region)** • The legal-administrative intervention of biomedical sciences; from bioethics to bioregulation.	

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
SCHOOL OF THE HUMANITIES, COMMUNICATION AND DOCUMENTATION - LIBRARY SCIENCE AND DOCUMENTATION			
Technologies Applied to Information and Documentation (TECNODOC) **PI: Antonio Hernández Pérez, Tomás Nogales Flores**	• Health documentation.	**R&D National Plan Projects** • On-line training in "Sources of information in Health Sciences" intended for healthcare professionals. • Support and management of the survey on healthcare strategies in palliative care, diabetes, cancer and heart diseases. • Consultancy, Technical Assistance and Training in the Area of Patient Safety.	**Experience and Capabilities** • Group specialising in audits and in starting up projects relating to the implementation of digital information systems.